Sustainable Rebuilding Ideas

smarter choices for better homes

Victoria
We will rebuild

Sustainability victoria

Victoria
The Place To Be

> introduction

How can these fact sheets help improve my new home?

These Sustainable Rebuilding Ideas have been compiled to assist people to rebuild homes that were damaged or destroyed in the 2009 Victorian Bushfires. The Sustainable Rebuilding Ideas fact sheets include a wide range of information about how to easily incorporate smart features into your house that will make it more comfortable, save you money and reduce its impact on the environment.

Research to get it right

The fact sheets have been developed to help you find the information you will need to design and build a high quality home. They are intended to give you sufficient information to have an informed discussion with your designer, builder or environmental professional.

Useful design principles

The fact sheets address a number of simple design principles that will significantly improve the performance of your new home. These features are most cost-effective when they are considered from the start of the design process, rather than being seen as something to be added in at the end.

Rebuilding for better bushfire safety

Victorian building regulations control the construction of buildings in bushfire prone areas. The regulations improve the ability of buildings to withstand bushfire attack and help improve human safety. It is a systematic way of using home construction to provide better ways of dealing with bushfire attack from:

- burning embers
- radiant heat
- direct flame contact
- wind effects accompanying bushfires.

We have included some general notes and principles in these fact sheets to help you consider the implications of incorporating environmental features in your home, but you'll need to get specific advice about rebuilding for improved bushfire safety and complying with the Victorian Building Regulations.

In all cases, you must start with a Bushfire Attack Level (BAL) assessment, with guidance and typical requirements available from the Building Commission. This sets the range of mandatory requirements from within the AS 3959-2009. You or your builder will need to understand what this means for you and your home before you finalise your rebuilding contract. If you don't do this in advance, you could have some annoying and expensive changes to your project. So get good advice early!

Building Commission Bushfire Building Advice Line 1300 360 320 (9–5pm Monday to Friday)

www.buildingcommission.com.au

What fact sheets are available?

The information provided in the fact sheets is arranged in topics or chapters. The fact sheets that are most relevant will depend on the stage of the design and construction process you are in and on your specific situation.

You may choose to read these fact sheets in the order they are listed or just select the fact sheets that address the issues that are of most interest to you. Remember to use the reference section to follow up any further information that you need.

Where can I get copies of these fact sheets?

Copies of these fact sheets are available from VBRRA Information Centres, or by calling Sustainability Victoria's Information Line on 1300 363 744.

The fact sheets are also downloadable from Sustainability Victoria's website resourcesmart.vic.gov.au/sustainablerebuildingideas

What if I still have questions?

These fact sheets cannot replace the face-to-face discussions and advice that you will get from design, building and environmental professionals. After reading these fact sheets, we recommend you seek advice from specialists who can give you more detail and explain some of the principles that you will need to consider before you start building. They will also be able to help you with the more detailed decisions that will need to be made throughout the rebuilding process.

For further information or for copies of these fact sheets, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

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Find out more at resourcesmart.vic.gov.au

Sustainable rebuilding ideas

Passive solar design

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> climate and comfort

Included in this fact sheet:

> Climate zones
> Understanding your climate
> Design and climate links
> Heating and cooling requirements
> Understanding thermal comfort

This fact sheet presents background information relating to climate zones in Victoria, their impact on residential energy requirements and factors influencing our perception of thermal comfort.

Climate zones in Victoria

The climate of where you live needs to be taken into consideration when designing a home for comfort and energy efficiency. Across Victoria, there can be considerable differences between maximum and minimum temperatures in summer and winter, as well as temperature differences between day and night, and the length of the heating and cooling seasons. Good building design should account for these climate variations and be tailored to the specific area in which you live.

House design in different climate zones

Winter heating is the predominant concern of householders throughout all of Victoria, with summer cooling requirements being less significant.

To achieve the best results, the choice of housing design and construction materials should be appropriate to the climate of a region (macro-climate). While each climate zone has different heating and cooling needs, the same principles of energy efficient house design apply, with their application varying slightly, e.g. different levels of insulation or thermal mass or variations in window sizes.

In addition to general energy efficient design principles, houses in cooler zones require attention to higher insulation levels, winter window protection, draught proofing and summer shading.

Thermal comfort

Thermal comfort refers to the range of conditions in which the majority of people feel comfortable. This is a limited range, as we need to maintain a relatively stable body temperature of 37°C.

Our bodies produce heat mainly through activity, and give off heat according to the surrounding environmental conditions.

As shown in Figure 1, heat is lost from the body in three main ways:

> radiation 45%
> convection 30%
> evaporation 25%.

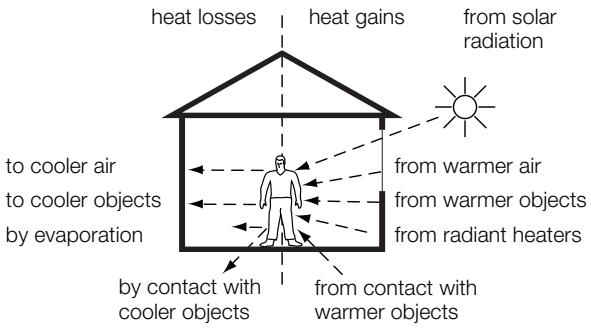

Figure 1: Main factors affecting body heat gains and losses inside a building

Thermal comfort variables

Comfort is influenced by the six main variables listed below:

1. **air temperature** (also called dry bulb temperature): the most common measure of thermal comfort
2. **mean radiant temperature**: the weighted average temperature of all exposed surfaces in a space. Discomfort may be experienced when there is a large difference between internal surface temperatures (e.g. uncurtained windows) and the internal air temperature, causing radiant heat to be lost from the body to the cooler surfaces
3. **relative air velocity**: important in warm weather, as air moving across the skin increases heat loss by convection, lowering the perceived air temperature
4. **humidity**: the moisture content of the air is defined as relative humidity and may cause discomfort when above 70% or below 30%
5. **activity levels**: lower air temperatures are acceptable when users of the space have higher activity levels, reducing their heating needs
6. **thermal resistance of clothing**: lower air temperatures are acceptable if users of the space wear warm clothing or use enough blankets to lower their heating needs (e.g. in bedrooms at night).

Building design affects the first four of these thermal comfort variables, while the last two depend on the behaviour and actions of people. With an understanding of the effect of building design on thermal comfort, designs may be manipulated to achieve particular comfort levels.

Perception of comfort

There are considerable individual differences in perception of comfort. For example, older people tend to have different heating requirements. There are also differences between the sexes. These differences are often reflected in varying energy costs for homes.

The general rule for combining comfort and energy efficiency is to aim for the **lowest comfortable temperature** in winter, and the **highest comfortable temperature** in summer. For example, the recommended winter heating temperature range for living areas in Melbourne is 18–21°C, and 24–27°C for summer cooling. Keeping thermostats to these settings can considerably lower heating and cooling energy needs and costs.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

www.yourhome.gov.au

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> house siting and solar access

Included in this fact sheet:

- > **How best to site your house**
- > **The benefits of the sun**
- > **The best use of natural light**
- > **Internal design maximisation**

This fact sheet outlines the relationship between site layout, solar access and energy efficient house design. It also provides a guide to siting a home on a block and internal planning for maximum energy efficiency.

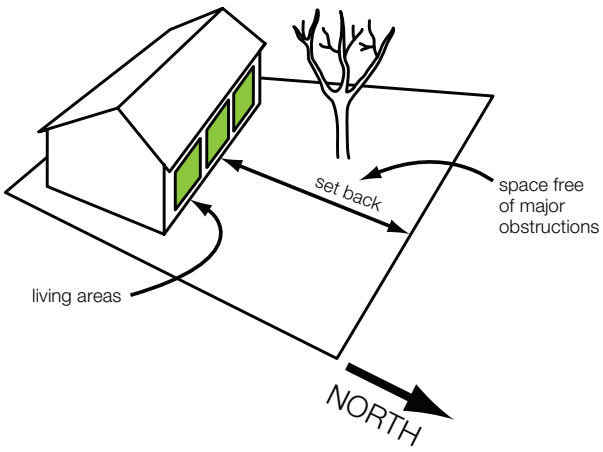

Figure 1: Unobstructed space to the north for good solar access

Benefits of solar access

Solar access refers to the amount of the sun's energy available to a building. Ensuring your home has good solar access results in free heating from the sun, reduced energy requirements, improved comfort levels and environmental benefits.

Siting for solar access

To achieve a high level of unobstructed winter sunshine, it is essential to choose the correct siting and orientation for your house (see Figure 1). A house should be designed to respond to site conditions to maximise free solar energy.

Diffuse and direct solar radiation

Solar radiation encompasses both direct and diffuse solar energy. Direct solar energy is the sunlight that falls upon the window, whereas diffuse solar energy is the reflected energy that still comes through the window on a cloudy day. In Victoria, up to 40% of the energy contribution from north windows in the colder months is from diffuse solar radiation.

Solar access for lots

Good solar access for new housing depends very largely on the site. Energy efficient housing can be provided more easily and economically if the lot allows a home to be sited with good solar access. Characteristics such as orientation, slope, existing or potential overshadowing from the north, and lot shape, size and width are important considerations. For this reason, correctly siting the home to utilise solar access is a fundamental design decision.

Find out more at resourcesmart.vic.gov.au

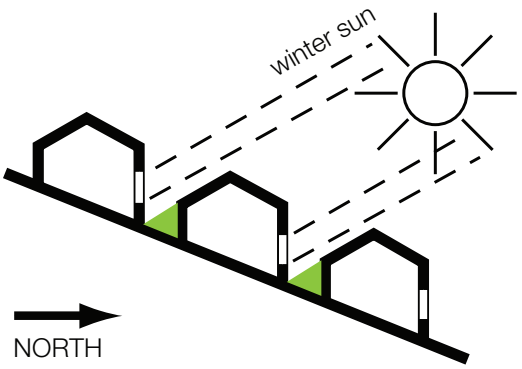

Figure 2: Distance between homes can be less on north-facing slopes

Placing your home on the block

Ideally, your home should be placed on the block so that its living areas and major windows face north. Renovations and extensions to existing homes should also use this principle to make them energy efficient. If you cannot do this on your block, a high level of energy efficiency can still be achieved by turning your attention to other higher cost, energy efficient features such as extra insulation and double glazing.

Alternatively, your home can be specifically designed to catch the winter sun even on a block with otherwise poor solar access.

Local council approval process

A new planning scheme provision, Clause 52.39 – 2009 Bushfires – Replacement Buildings has been produced to enable landowners to rebuild houses without having to satisfy the normal planning scheme requirements.

This provision was created to simplify your local council's site plan approval process, enabling you to then seek building approval and begin rebuilding as swiftly as possible. This also provides a great opportunity to maximise energy efficiency in the early stages of your design process. For more information please visit: www.wewillrebuild.vic.gov.au

Design guidelines

> Consider sharing walls with neighbours, particularly on the east or west boundaries (see Figure 3).

> Keep north-facing walls and windows well back from large obstructions to the north (such as buildings, trees or fences) as they cast shadows two to three times their height in mid winter. A distance of at least 5.5 m from a single-storey obstruction to the north, or at least ten metres from a double-storey obstruction, is recommended (see Figures 4 and 5).

> If solar access is poor, consider alternative methods to gain northerly winter sunlight into the home, such as using high clerestory windows (see Figure 6).

> Consider building on the south, east or west boundaries. If this is not possible, at least place the home close to the southern boundary.

> Avoid placing garages, carports and other buildings on the northern side of the block.

Figure 3: Wise house placement close to east, west and south boundaries maximises solar access

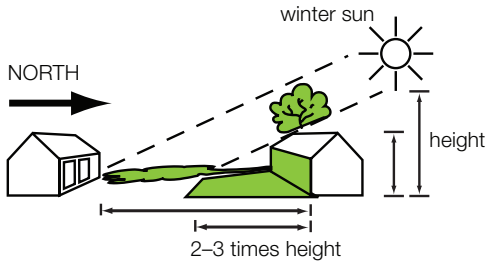

Figure 4: Objects cast shadows two to three times their height in winter

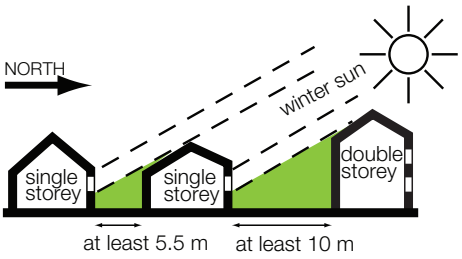

Figure 5: Allow adequate distance from obstructions to the north

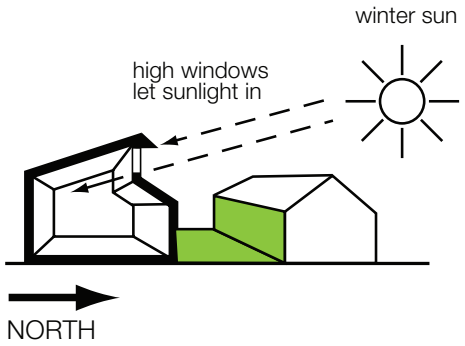

Figure 6: Overcome problems of winter overshadowing with clerestory windows

Internal planning and room placement

Rooms are used for different purposes at different times of the day and their location will influence energy efficiency and comfort levels.

Avoid large, open-plan living areas that have to be heated at a time when only small areas may be in use.

Creating zones by grouping rooms with similar uses and closing off unheated rooms reduces heating and cooling needs. Grouping together rooms that use hot water (such as a laundry and bathroom) also improves the efficiency of hot water usage.

Daytime living zones (family rooms) with northerly aspects are warm and bright during winter and can be easily protected in summer, improving energy efficiency and making them comfortable all year round.

Stairwells and high ceilings can increase your home heating requirements by more than 40%. They allow heated air to rise, leaving cooler air at the lowest floor level, and increasing the volume of air that has to be heated.

Correctly placed windows and doors with short distances between them encourage cross-ventilation to help cool the home on summer evenings.

Design guidelines

> Group rooms with similar uses together and use doors to separate the various areas of your home into zones. Use glass doors or bi-fold doors to retain the open-plan aesthetic where necessary.

> Use doors to separate formal living areas from other living areas, and heated areas from unheated areas.

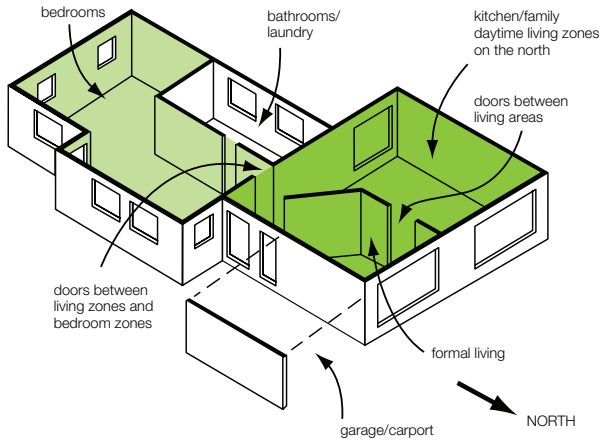

Figure 7: Zoning of a home for a narrow north-south block

> Place daytime living areas such as kitchens, family and rumpus rooms to the north. Other zones can be arranged around the daytime living area depending on their use.

> A northerly aspect for formal living and dining areas is desirable, though not essential. A westerly aspect should be avoided.

> Avoid deep verandas on the north side of your home, as these will remove the benefit of solar heat gain in winter.

> Avoid a westerly aspect for bedrooms. An easterly or northerly aspect is desirable for children's rooms and playrooms. Rooms with a southerly aspect will be cooler all year round.

> Group together areas that use hot water to minimise plumbing costs, heat loss from pipes, and water wastage.

> Use utility areas such as bathrooms, laundries and toilets as buffer zones on the west and south sides of the home.

> Be careful not to place rooms or garages where they will overshadow northern windows during winter mornings or afternoons. Avoid deep north-facing courtyards (see Figures 9 and 10).

> Locate garages and carports on the east, west or south sides to protect the rest of the home from summer sun and winter winds (see figures 7 and 8).

> Create airlocks at external doors to limit the escape of heated air when the external doors are opened.

> Keep ceiling heights low, preferably no higher than 2.7 m. Voids and cathedral ceilings are not recommended. If high ceilings are essential to the design outcome, consider using ceiling fans, which can run in the reverse mode. This pushes warm air up against the ceiling and then down the walls, gently re-circulating warm air through the room.

> Place doors at the base of stairwells to prevent heated air being lost. Avoid 'open' stairways in heated areas.

> Place openable windows and external doors on different sides of the home. Keep paths short and direct (less than 8 m) to encourage cross-ventilation (see Figure 11).

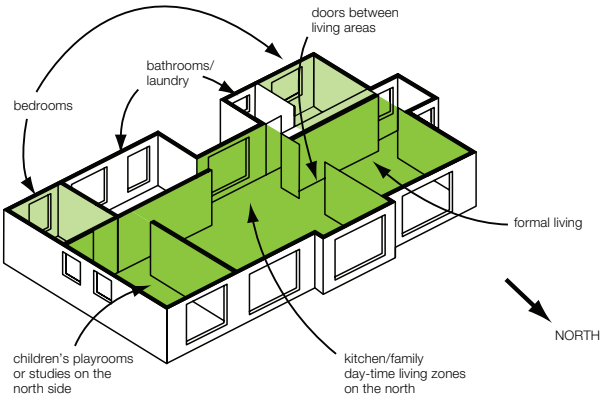

Figure 8: Zoning of a home for a narrow east-west block

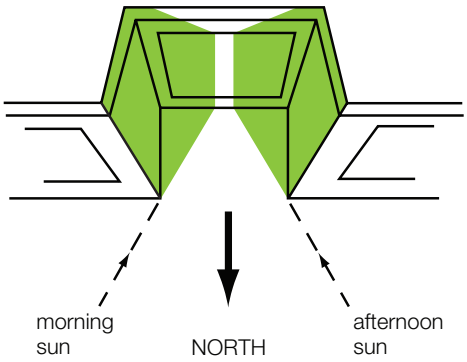

Figure 9: Deep north-facing courtyards are overshadowed by the side walls in winter

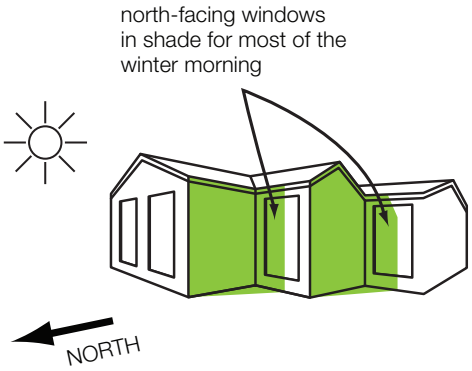

Figure 10: East and west-facing walls can shade adjacent north-facing windows in winter

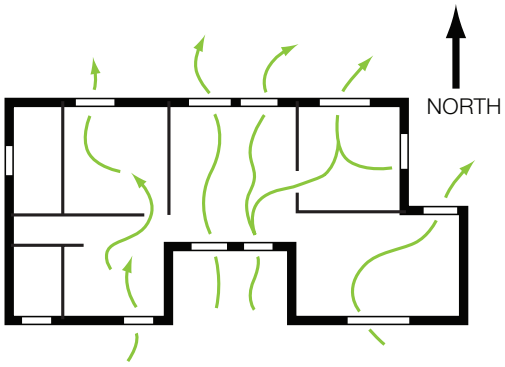

Figure 11: Cross-ventilation can provide most of your summer cooling needs

Siting for better bushfire safety

Exactly where you build on your block within a bushfire prone area can make a big difference to your design, construction and building budget. That is because the revised Australian Standard 3959-2009 is now mandated across Victoria.

The relationship between your home site, landscaping, native vegetation and your home design and construction needs to be considered as an integrated whole. You can site your home for greater bushfire safety by following a few easy principles. Where these can't be met, there may be a 'trade-off' with higher bushfire attack levels (BAL) from AS 3959-2009. Effectively, this means some increased restrictions on construction and some higher costs in rebuilding. But this is necessary both for your own protection and that of others, such as fire fighters.

Vegetation types and proximity

Our native vegetation has adapted to bushfires, better then we have. Areas of forest and woodland will usually create a far more intense bushfire than scattered bush, lawns and exotic planting. So the Australian Standard requires an assessment of the types of vegetation and their distance to your home, shed or garage. The higher the vegetative fuel load and the closer the vegetation, the greater the bushfire risk.

To minimise bushfire risk and your BAL, assess what types of vegetation are nearby, their density and their closeness. The bigger the separation distances from the vegetation to your home, the lesser the bushfire risk. The closer it is, the higher the risk.

Slope of land

Bushfires accelerate up slopes. In fact, they double in speed with every extra 10° of slope. Therefore it is safer from a bushfire perspective to build on flatter land and with less vegetation around, than upslope amongst woodland or forest, where there is a greater risk of a faster and more intense bushfire. In some cases, you can cut your home into the land to reduce your bushfire exposure. In other cases, you may need to reduce and/or thin the native vegetation nearest your home. A site-specific solution must be developed that meets your needs with better bushfire safety through your BAL assessment.

Aspect

Whilst northerly facing buildings and glazing are essential for passive solar design and your personal comfort (see Figure 12), bushfires do not respect orientation. Typically, northern and western orientations will provide drier, more flammable vegetation. Then again east and south might have higher fuel loadings from better growing conditions. Although the bushfire threat may commonly be driven by the prevailing summer wind pattern, local topography, dry vegetation or flying embers often send the fire in different directions. Hence the bushfire regulations do not consider aspect, but you should consider aspect and orientation – both for solar design and better bushfire safety.

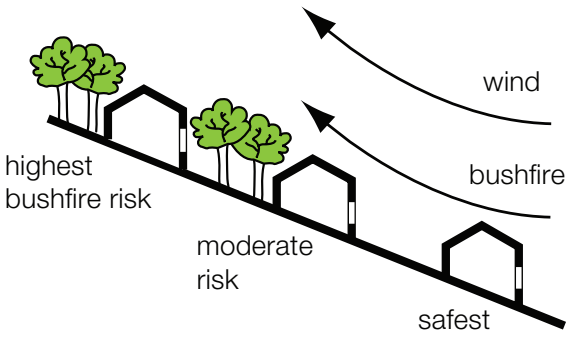

Figure 12: Bushfire risk and house siting on a slope

Bushfire safety considerations

Here is a brief overview of some of the key issues for consideration for protecting your home against radiant heat, flames and ember attack. We can't outline every matter covered by the Australian Standard and building regulations so you will need to seek specialist advice on how to comply with the regulations and maximise your safety.

House siting and landscape

> Site your home to minimise bushfire risk and BAL.

> Appreciate native vegetation whilst at the same time keeping the most flammable separated away from your home (this gap is sometimes called an 'asset protection zone' or 'defendable space').

> Research which garden or landscape species will thrive in your location without increasing the bushfire risk. Some species with higher leaf moisture content can help defend your home.

> Remove overhanging trees

> Where possible, cluster your home with others and/or have access roads and clearing between your home and the likely fire front.

> Design a home of simple form so that embers do not lodge in corners or around projections and cause ignition.

> Garages, carports, etc that are located near your home will need to address bushfire issues equally. (as explained in the Standard AS 3959-2009).

Summary

New planning requirements allow those bushfire-affected to rebuild with minimal controls but the requirements of AS 3959-2009 will nevertheless apply.

Siting, landscaping, vegetation, slope and aspect all affect your bushfire risk.

All these matters must be considered and assessed when planning to rebuild in bushfire areas.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

www.yourhome.gov.au

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Notes

> windows

Included in this fact sheet:

- > **The benefits and principles of good window design**
- > **Best window orientation and size**
- > **Shading and window protection**
- > **Window types**
- > **Window Energy Rating Scheme**

This fact sheet contains information and recommendations for the sizing and placement of windows, together with details on how to maximise winter sun penetration while minimising excessive summer heat gain and winter heat loss.

Benefits of good window design

Windows are a vital part of any home – they allow natural light into the home and provide views and fresh air. Well-planned and protected windows improve comfort year round and reduce the need for heating in winter and cooling in summer.

Window size, orientation, glazing treatment, shading and internal coverings can have a significant impact on your home's energy efficiency and comfort. Designing north windows for maximum solar access can reduce winter heating bills by up to 25%. External shading can block up to 80% of summer heat gain through windows. Internal window coverings and double glazing can reduce winter heat losses by around 40%.

Window design and shading principles

The four main principles of energy efficient window design and selection include:

1. maximise winter heat gain by orientating windows to the north and sizing windows to suit the amount of thermal mass in the dwelling
2. minimise winter heat loss through appropriate window sizing, together with double glazing and/or close-fitting internal coverings such as drapes with pelmets
3. minimise summer heat gain by protecting windows with external shading devices, and through the appropriate sizing and positioning of windows. The same principles apply to other types of glazing, such as glass doors, roof windows and skylights. (Wherever the term 'window' is used in this fact sheet, it encompasses all forms of glazing.)
4. consider your window type, materials and glazing according to your Bushfire Attack Level (BAL), derived from AS 3959-2009.

The new building standard

The new building standard has been designed to improve the ability of buildings to withstand a bushfire attack and has six levels of risk based on the BAL, with increasing construction requirements ranging from ember protection at the low levels to fire-rated construction at the highest.

For windows, the new requirements range from installing thicker toughened glass to bushfire shutters or bushfire-approved window frames. It is important that your building designer incorporates the new standard when designing your home. The new requirements can be found on the Building Commission's website or you can call the Bushfire Building Advice line on 1300 360 320 for more information.

Heat flow through glass

The main heat gain through windows is due to solar radiation. Windows receive this as both diffuse radiation reflected from the sky and ground, and direct radiation when the sun shines on the window. On average, between 30-40% of total radiation to north windows is diffuse, depending on weather conditions.

The heat flow through the glass should be used to advantage in winter to keep a home warm. In summer, however, it should be avoided by shading glass from the direct rays of the sun.

Window orientation

The amount of radiation received by a window varies according to orientation and time of year.

Figure 1 shows the range of orientations for Victoria within which a window is regarded as facing north, east, west, or south. These orientations are used for all tables and calculations in this fact sheet.

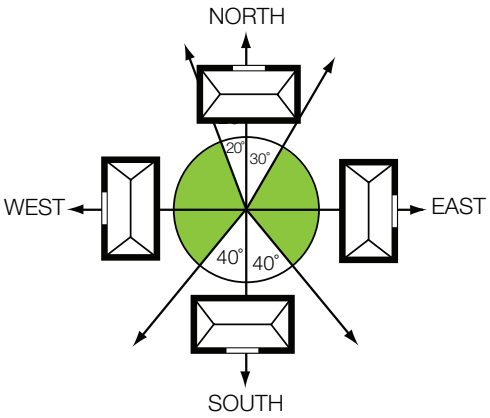


Figure 1: Window orientations considered to be north, east, west and south

During summer, all windows receive net heat gains, but especially those facing east and west.

Figure 2 compares the summer radiation received by windows of different orientations with the heat given out by a two-bar radiator operating three hours per day. As can be seen, most unshaded windows receive substantial heat gains.

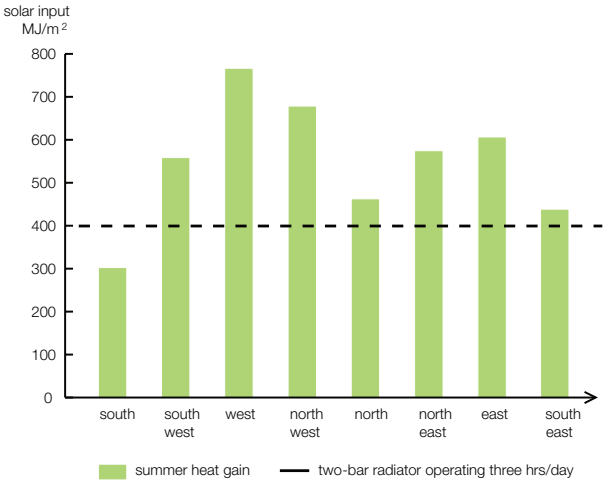


Figure 2: Window orientation and summer radiation (unshaded glass)

In winter, the situation is different. Only windows facing north, north-west and north-east have a net heat gain over winter, with heat gains outweighing heat losses (see Figure 3). Although east and west windows receive substantial solar radiation in the morning and afternoon respectively, the overall heat losses outweigh the gains over a 24-hour period. Windows orientated to the south also have a net heat loss.

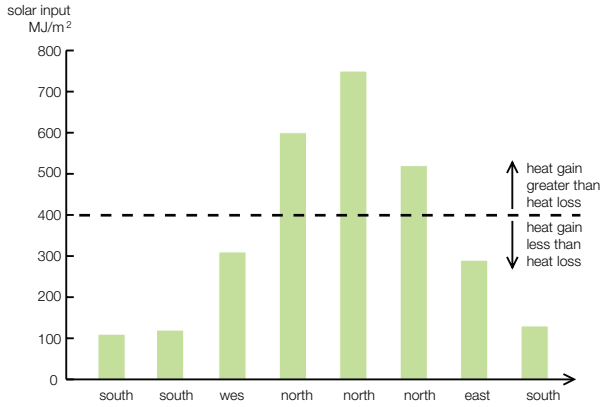


Figure 3: Window orientation and winter radiation (unshaded glass)

Optimum window size

The most appropriate size of windows for energy efficient design depends on the orientation of the building and the amount of thermal mass in the internal building materials. The total glass area is best kept between 20-25% of the total floor area for brick veneer houses and 22-30% for double brick houses. Your Thermal Performance Assessor will be able to help you with getting this balance right.

Three factors to consider in sizing windows include:

1. window area must be kept within acceptable limits
2. a balance of north, south, east and west oriented areas of glass should be used
3. glass in individual rooms should be correctly sized.

In addition, Victorian building regulations require a minimum glass area of 10% of the room's floor area for each habitable room. Your Thermal Performance Assessor (refer to fact sheet – Measuring Your Home's Energy Efficiency) can help you assess how varying glass areas, window orientations, shading, internal coverings or double glazing can affect energy efficiency.

Clerestory windows

North-facing clerestory windows should be considered as they can be particularly useful where there is a building obstructing solar access to the north (see Figure 4). A simple eave overhang for a northern orientation can shade clerestory windows. For east and west-facing clerestory windows, internally-operated adjustable louvres or blinds installed internally or externally, or sandwiched between two panes of glazing, can be used. Tinted glass could also be considered, although this will reduce winter light and therefore heat gain.

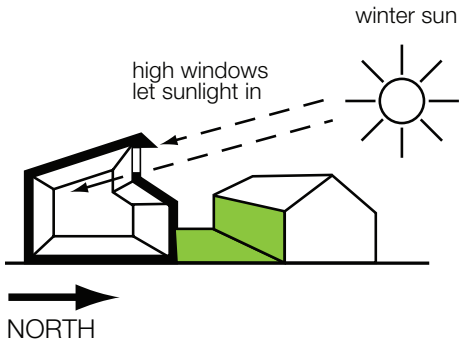


Figure 4: North-facing clerestory windows can provide solar access

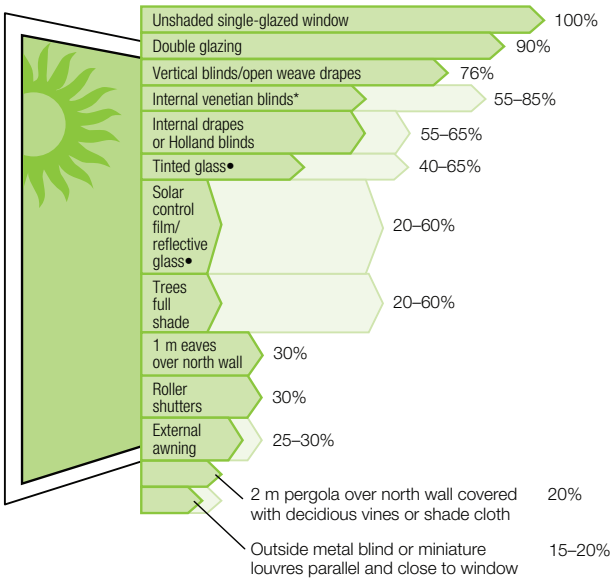
Shading and window protection

Reducing summer heat gain

External shading devices are an effective way to reduce heat gain through windows in summer and keep your home cool. They provide much better protection from heat gain than internal window coverings. External shading reduces heat gains by 70-85%, whereas internal coverings can reduce heat gains by as little as 15% (see Figure 5).

Shading devices should allow for ventilation on the outside of the window. If shading is fitted too closely to the window, warm air can be trapped and heat conducted into the room.

If external shading is not feasible, internal shading devices such as close-fitting blinds, lined curtains or internal shutters are preferable to no shading at all.



* Effectiveness is reduced as the colour darkens
• Solar film, tinted glass and reflective glass of varying effectiveness is available. They significantly reduce light levels all year round.

Figure 5: Comparison of heat gains through different window treatments in summer

Fixed or adjustable shading

Fixed shading includes structures such as eaves, pergolas or verandahs, which are usually a part of the building structure. They are only appropriate for use over north-facing windows. Although fixed devices provide effective protection from heat gain, they lack flexibility in situations where shading may be needed one day but not the next. However, fixed shading is durable and does not require ongoing adjustment. It is important to allow an adequate distance between the top of the window and the underside of the shading device. This avoids partial shading of the window in winter.

Adjustable shading devices can also be used. These include canvas blinds, conventional or roller shutters, angled metal slats and shade cloth over pergolas. Such devices permit greater flexibility to make adjustments on a day-by-day, or even hour-by-hour, basis, in response to changing weather conditions and individual comfort levels. They can also be completely retracted to maximise winter solar access. Bear in mind that any adjustable device will require human participation (see Figure 6).

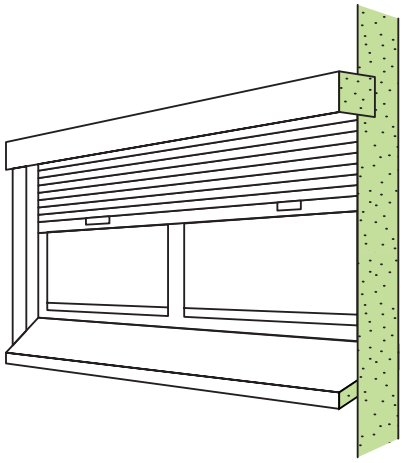


Figure 6: Adjustable external shading devices

If your property requires bushfire shutters under the new standard, it is worth investigating the potential to use the shutters as shading devices to block the summer sun and allow the winter sun in. This integrated approach will help you save on material costs.

Calculating the size of north-facing shading devices

To provide full shade from late October to late February in Victoria, the depth of the horizontal overhang should be approximately 45% of the vertical height to be shaded, measured from the sill of the window to the underside of the shading device (see Figure 7). This depth represents an acceptable compromise between shading in late summer and direct solar gain in late spring, while allowing winter sun to penetrate fully.

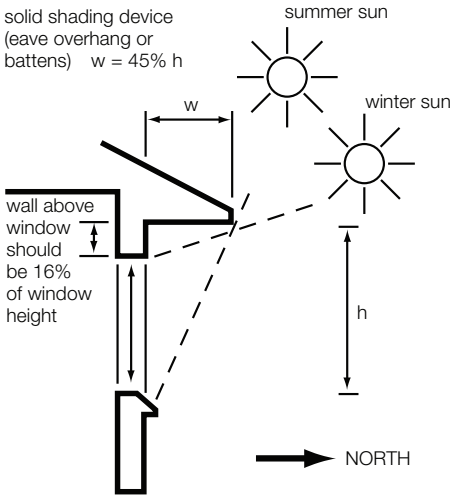


Figure 7: Rule of thumb for sizing north window overhang

Note that, if possible, the window should not extend fully to the underside of the overhang, as this will create an area of glass in perpetual shadow (and thus subject to permanent heat loss).

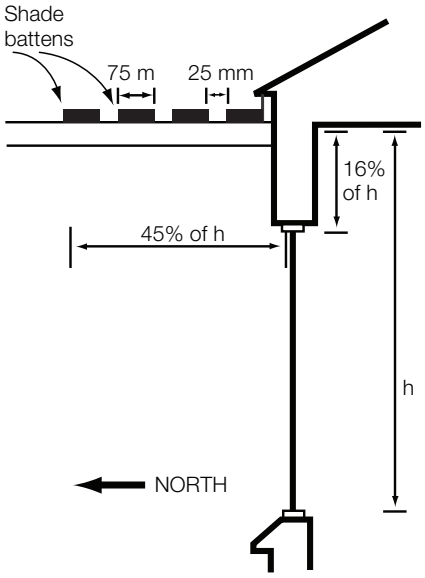


Figure 8: Use of shade battens on pergolas

Width of shading device

For horizontal shading to be effective, it should extend past the edges of the window for at least the same distance as its depth (see Figure 9).

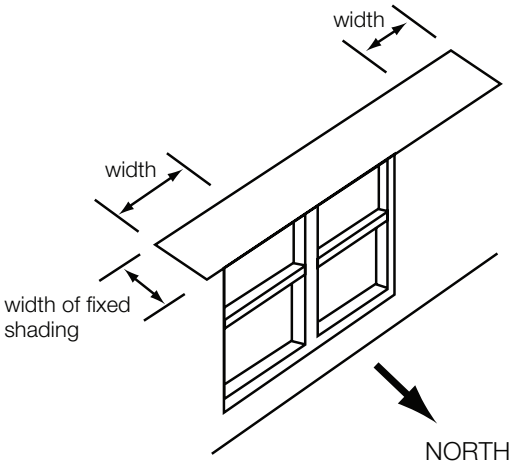


Figure 9: Extend window shading beyond the window edges

Internal window coverings

Internal window coverings are used to trap a layer of still air between the glass surface and the covering, reducing heat flow through the glass (see Figure 10). To maintain the still air layer, coverings must be opaque and closely woven, be fitted completely over the window and have a barrier at the top, such as a boxed pelmet. Alternatively, they should be recessed into the window reveal (see Figure 11).

Appropriate coverings include drapes, Holland blinds, Roman blinds and Austrian blinds. Avoid vertical blinds, conventional or timber venetians, which do not give a good air seal. Thin or lace curtains should be used in conjunction with appropriate coverings. Also note that internal window coverings are not included in the thermal performance rating for the 5-star standard.

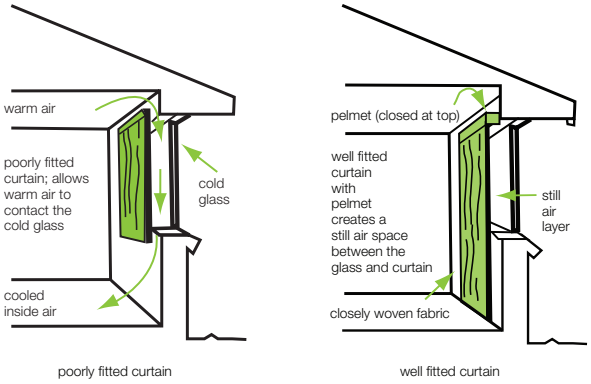


Figure 10: Features of effective window coverings

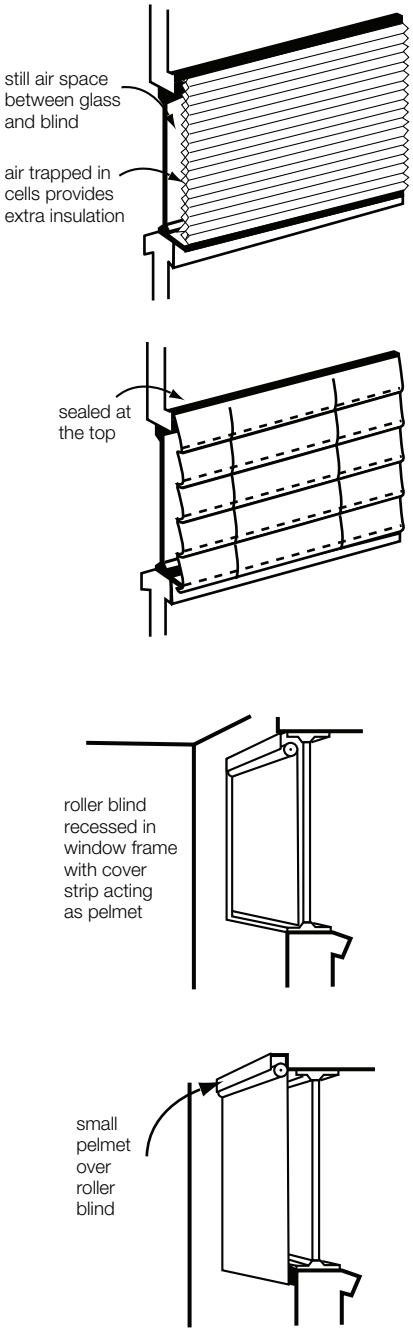


Figure 11: Features of effective window coverings

Window materials

Toned glass and reflective films

Glass can be treated to reduce the amount of solar energy transmitted through it. This can be an alternative method of preventing summer heat gain where external shading devices are inappropriate (such as for windows that are inaccessible or have views that must be maintained). However, treated glass must be used with caution, as it reduces heat gain and light in winter as well as summer.

Toned glass

Toned glass has a tint applied to the glass during manufacture to reduce the amount of heat transmitted through it. There are two main types of toned glass available:

1. basic tones, usually bronze, grey and green
2. super tones, which offer a higher level of performance, such as EverGreen™, SuperGrey™, SolarGreen® and Azurlite®.

Reflective coatings

Reflective coatings can be applied to new and existing windows. They tend to be better at preventing heat gain than some toned glass, and increase privacy by blocking vision into your home. To ensure optimum performance, films should be applied professionally.

Low emittance glass

Another method of reducing heat loss through glazing is to use low emittance (low-e) glass. This glass has a special coating that allows light from the sun to pass into the house, but stops heat escaping through the window.

Low-e coatings can be ‘hard’ or ‘soft’ and can enable a very dramatic improvement in comfort levels. But they must be employed correctly or they will either deteriorate or fail to perform to specification. The Australian glass industry manufactures a wide range of high-performance, low-e coated glass products, and imported products are also available.

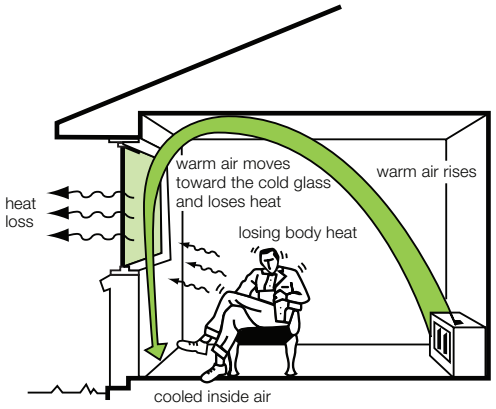


Figure 12: Unprotected glass and winter discomfort

Safety glass

The Building Code of Australia requires that window glass near the floor and/or glass doors must be ‘safety glass’ according to the Australian Standard. This is for personal safety. Similarly, AS 3959-2009 requires that (depending upon the BAL), toughened glass be used in higher bushfire zones. That is because this glass performs better at the higher heat intensity than ordinary (annealed) glass. The same toughened glass process can also be used for toned, coated or treated glass, plus double glazing – all at a price.

Double glazing

Double glazing is another way to stop heat loss through windows. Although useful for any window, it is vital that it be used if internal coverings are not desired or are inappropriate, such as in the kitchen, for highlight or clerestory windows, or simply those where unobstructed views are desired.

Double glazing does not impede solar heat gain. Therefore, it will still allow winter sun penetration. Unprotected double-glazed windows will still require appropriate summer shading. Double glazing can incorporate most types of glass and is available with toned, laminated and toughened glazing. For optimum performance, the space between the two panes should be at least nine millimetres. However, increasing it above 15 millimetres will not provide any extra significant thermal benefits.

Double glazing can be used in most situations, but is particularly appropriate:

> in cold or alpine climates
> in skylights, clerestory windows and roof glazing
> for large areas of glazing
> where curtains or other window coverings are not used
> where energy costs are high.

Window frame material

The material of the window frame can affect overall window performance. Materials with high heat conductance cause more rapid heat loss from the heated interior in winter and higher heat gain in summer. PVC and timber frames generally perform better than metal frames, unless metal frames are designed with thermal breaks to decrease conductance across them (see Figure 13). The material of a window frame can affect overall window performance, and in many cases, be mandated for a higher bushfire protection BAL. Australian hardwoods and PVC meet many requirements at lower bushfire levels, but only a selected number of timber species (listed in AS 3959-2009) will meet higher bushfire requirements. Aluminium or steel frames meet most requirements for bushfire protection, but other criteria emerge if seeking better thermal performance Figure 14 compares the percentage energy savings of different window frames and glazing when compared with single-glazed aluminium frames.

Frame material	U value of glazing type (w/m²/°c)		
	Single glazing	Double glazing	Double and low-e coating
PVC/timber	4.5	3.0	2.4
Aluminium	5.5	4.0	3.3
Aluminium – with thermal break	4.6	3.1	2.5

Figure 13: Total heat transfer through windows

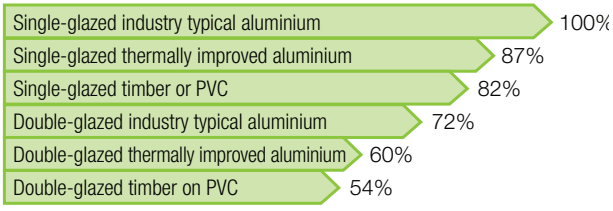


Figure 14: Comparison of heat loss through different window frames

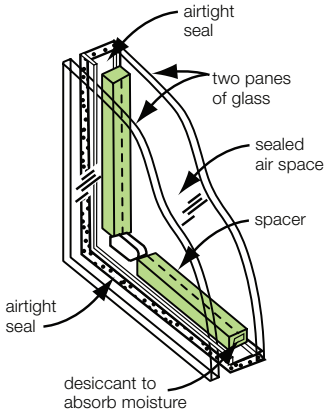


Figure 15: Typical double-glazing system

Window Energy Rating Scheme

The Window Energy Rating Scheme (WERS) is a program implemented by the Australasian Window Council (AWC). WERS is independent of any one manufacturer and acts as a fair, rigorous and credible system for testing window performance. The AWC rates a window's energy performance in terms of stars. No stars means that the window is a very poor performer while 5 stars indicates an excellent performer (see Figure 16). The aim of the scheme is to help you evaluate the relative energy performance of different types of windows, so you can make an informed decision suited to your needs.

Windows To Keep You Cool

Number of stars	Indicative improvement
NIL	0%
★	12%
★★	24%
★★★	36%
★★★★	48%
★★★★★	60%

Windows To Keep You Warm

Number of stars	Indicative improvement
NIL	0%
★	9%
★★	18%
★★★	27%
★★★★	36%
★★★★★	45%

Based on the amount of energy required to heat or cool a typical house, when compared with using clear, single glazed aluminium windows

Figure 14: Percentage improvement in heating and cooling is represented by the number of stars

The window manufacturer can display a label that shows the star rating for the window's heating and cooling performance. The label shows an indicative percentage reduction in the home's heating and cooling needs compared with using clear single-glazed aluminium framed windows and also the AWC Certified Performance Data (see Figure 17).

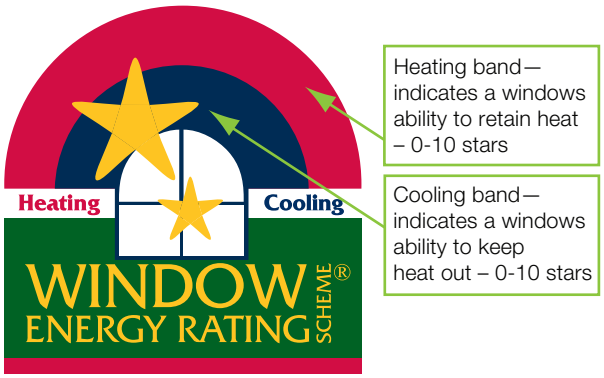


Figure 17: Window Energy Rating label

Skylights and roof glazing

Skylights and roof glazing can cause serious problems with heat gain in summer and heat loss in winter. Further complexities arise within bushfire zones, where particular requirements are mandated. The larger the glass area, the greater the potential for excessive heat loss or gain. It is vital to design and size these types of glazing correctly, as they can be difficult and expensive to correct once installed.

Roof glazing should only be installed where it is absolutely necessary and kept as small as possible. As it admits around three times as much light as the same area of vertical glazing (on average), there is no reason for it to be excessively large. Australian Standard AS4285-2007 provides recommended sizing guidelines for skylights.

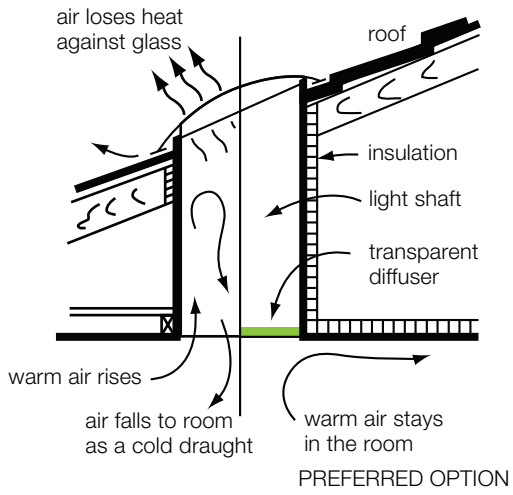


Figure 18: Skylight diffuser

Daylight tubes

Daylight tubes can be a more energy efficient alternative to conventional skylights. They consist of a clear, hemispherical dome, a smooth highly reflective tube and a diffuser at ceiling level (see Figure 19).

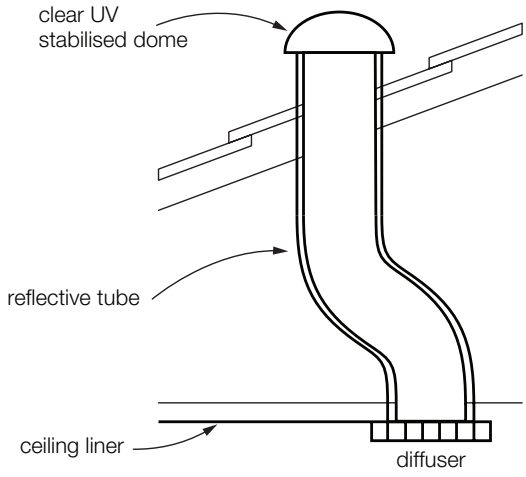


Figure 19: Daylight tube (bushfire requirements may apply)

As they require a smaller area of roof glazing than a traditional skylight, heat gain in summer and heat loss in winter is significantly reduced. They are best suited for use in smaller rooms such as bathrooms, hallways and entry areas. Note that tubes with textured, flexible ducts tend to deliver significantly less light than those with smooth shiny ducts. Bushfire requirements to AS 3959-2009 include non-combustible flashing requirements (low BAL) through to glazed ceiling-level diffusers and metal mesh ember guards over glazing and fire-rated assemblies. Once again, it's necessary to check with specific requirements within the Standard for your particular situation.

Bushfire safety considerations

Glazed windows, skylights and doors are especially vulnerable to bushfire attack.

Consequently AS 3959-2009 has an increased set of requirements depending upon the BAL.

It's important that these requirements be investigated early in the re-building process to avoid disappointment and additional cost later.

Door (and window) seals are required generally to ensure minimal gaps and cracks. Sometimes perforated metal screens or shutters are suggested.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

> insulation

Included in this fact sheet:

- > **The benefits and principles of good insulation**
- > **Understanding R Values**
- > **Fire safety and bushfire safety**
- > **Insulation materials**

This fact sheet outlines the benefits of insulation, how it works and the different types of insulation products available for use in your home.

Insulation benefits

Insulation is the most effective way to improve the energy efficiency of your home. Insulation of the building envelope helps keep heat in during the winter and reduce heat gain in summer.

Benefits of insulation include:

- > improved comfort levels throughout the year
- > reduced heating and cooling costs;
- > less need for heating and cooling, which saves non-renewable resources and reduces greenhouse gas emissions
- > condensation on walls and ceilings virtually eliminated
- > some insulation materials can also be used for soundproofing.

How insulation works

An uninsulated home is subject to considerable winter heat losses and summer heat gains (see Figure 1).

All materials allow a measure of heat to pass through them. Some, such as metal, glass or air, allow heat to pass through more easily. Others, including animal fur or wool, thick clothing and still air, are much more resistant to heat flow and are referred to as insulators.

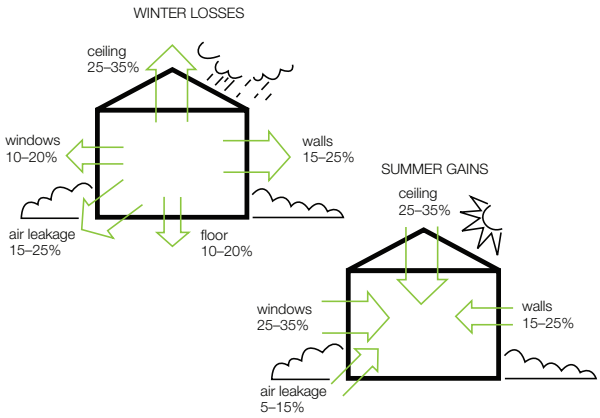


Figure 1: Heat flow without insulation

The term 'insulation' refers to materials that provide substantial resistance to heat flow.

When these materials are installed in the ceiling, walls and floors of a building, heat flow into and out of the building is reduced, and the need for heating and cooling is minimised.

Although ceilings and walls may be insulated, heat loss will still occur in winter through large areas of unprotected glass or through fixed wall vents and gaps and cracks around external doors and windows. Appropriate internal window coverings (e.g. lined drapes with pelmets) and draught proofing are vital to complement insulation.

Insulation should always be coupled with appropriate shading of windows and adequate ventilation in summer. Without shading, heat entering the home through the windows will be trapped inside by the insulation and cause discomfort (see Sustainability Victoria's Windows fact sheet for more information).

Find out more at resourcesmart.vic.gov.au

Understanding heat transfer

There are three ways in which heat is transferred – radiation, convection and conduction.

Radiation

Radiation is the direct heat that can be sensed by the skin, such as the sun's rays or the heat from an open fire (see Figure 2).

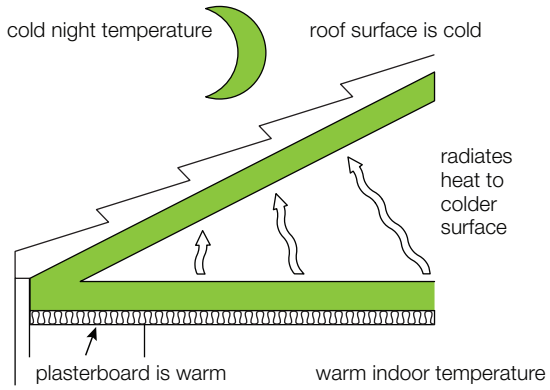


Figure 2: Radiant heat transfer

Convection

Convection transfers heat through the movement of gases or liquids. For example, when air is warmed, it rises and is replaced by cooler air (see Figure 3).

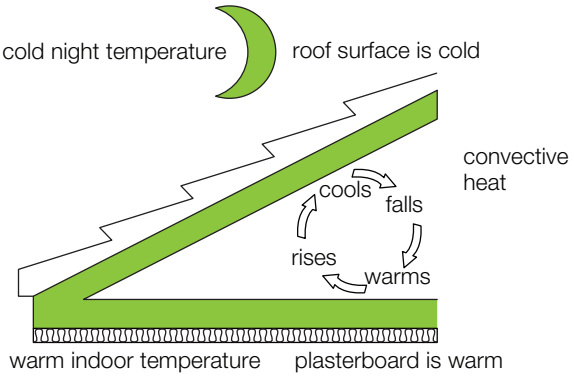


Figure 3: Convective heat transfer

Conduction

Conduction describes the heat transfer from warm to cooler areas within a material, or between two materials touching each other (see Figure 4).

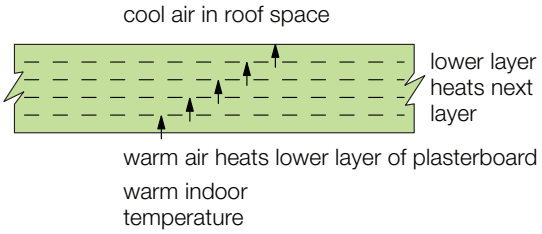


Figure 4: Conducted heat transfer

Principles of insulation

Resistance to heat flow is achieved by the use of either bulk insulation or reflective insulation, which work in different ways.

Bulk insulation traps millions of tiny pockets of still air or other gases within its structure. These air pockets provide the resistance to heat flow. Bulk insulation reduces radiant, convective and conducted heat flow (see Figure 5).

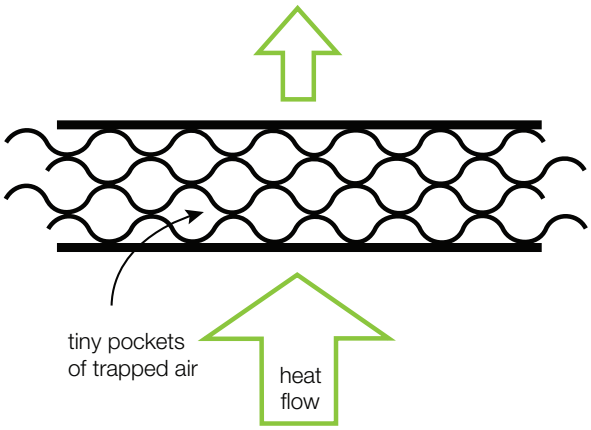


Figure 5: Bulk insulation and heat flow

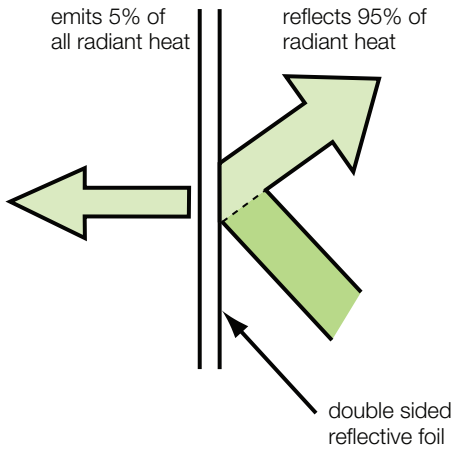


Figure 6: Reflective insulation and heat flow

Reflective insulation works by reducing the radiant heat transfer across an enclosed space, e.g. between bricks and plasterboard in an insulated brick veneer wall. Reflective foil in walls or under the roof reflects radiant heat away from the interior in summer. It works most effectively in conjunction with a still air layer (enclosed air space) of at least 25 mm (see Figure 6). Reflective insulation needs to remain clean and dust-free for best performance.

Overall R value

The overall R value is the total resistance of a building element. It takes into account resistance provided by construction materials used in a wall or ceiling, internal air spaces, thermal bridging, insulation materials and air films adjacent to solid materials. Each of these components has its own inherent R value, the sum of which provides the overall R value.

Added R value

The added R value or added thermal resistance is the value of the insulating material alone. This is the term most used when buying insulation.

The manufacturer should provide the R value of bulk insulation. Some products will trap air or gas more effectively, and so will have a higher R value for a specified thickness. For example, 45 mm thick extruded polystyrene and 80 mm thick glasswool both have an R value of approximately 1.5.

Reflective insulation must work in conjunction with enclosed air spaces between surfaces, and cannot be said to have an R value by itself. To compare the performance of bulk and reflective insulation, the resistance of any existing air space(s) must be calculated. Reputable manufacturers can supply this information. Note that the effectiveness of reflective insulation installed on horizontal or sloping surfaces will eventually be reduced due to dust build-up, which reduces reflectivity.

Recommended added R value

The minimum recommended added R value in Victoria is R3.5 or higher for ceilings and reflective foil will provide an added benefit in summer. Walls should be insulated with a minimum added R value of R2.0; anti-glare foil should also be added to brick veneer walls. Use sub-floor insulation if installing suspended timber floors, particularly if uncarpeted. The recommended minimum added R value for sub floors is R 1 if using bulk insulation or a reflective insulation with an air gap of 25 mm (minimum).

Your Thermal Performance Assessor will be able to help you determine the best added R value for your home. They can also provide advice on how best to meet the 5-star standard or to go beyond minimum compliance requirements.

R values of common wall construction types

Common building materials, such as brick, timber and tiles have little inherent insulation value. The R values of some typical forms of wall construction are shown in Figure 7.

Wall Construction	Overall R Value
Weatherboard	0.55
Brick veneer	0.51
Cavity brick	0.53
Solid brick (230 mm thick)	0.44
Solid concrete (100 mm thick)	0.23
Solid concrete (200 mm thick)	0.30
Aerated concrete (100 mm block)	0.78
Aerated concrete (200 mm block)	1.54
Mud brick (300 mm block)	0.40

Figure 7: Estimated R values of common wall construction types*

*As R value increases, the insulation benefit improves.

How to select your insulation

When selecting insulation, ensure that the material is:

> the recommended R value for the relevant area
> appropriate for the intended installation
> a material covered by Australian Standards or approved by other recognised testing authorities
> sufficient to meet local building authority requirements
> meets the requirements for your property's Bushfire Attack Level (BAL).

Fire safety

All insulation products should be independently tested for flammability prior to being sold. AS1530.1 (1994) provides a standard testing procedure to measure:

> ignitability
> the spread of flame
> if the material is heat evolved
> if the material is smoke evolved.

Cellulose fibre must be treated with a fire retardant such as a mix of borax and boracic acid during manufacture. This treatment ensures that if the material does ignite, the flame will not spread. Expanded and extruded polystyrene are combustible and should only be installed between fire-resistant surfaces (this includes plasterboard). Natural wool is flame resistant, provided only pure, new scoured wool is used. Wool that is oily (or has synthetic fibres mixed with it) is potentially flammable.

Suggested applications for insulation products

Figure 8 provides general information about the various insulation products currently available, together with the most common applications for each product. It is possible to adapt most products for different uses if required.

Figure 8: Insulation products and possible applications

	Insulating Material	Material Description	Typical Applications						
			Flat Ceilings Pitched Roofs	Cathedral Ceilings Or Raked Ceilings	Timber Floors	Suspended Concrete Slabs	Concrete Slab Edges	Full Masonry Walls	Framed Walls
Batts And Blankets	Glasswool	Manufactured from melted glass spun into a mat of fine fibre. Made to an Australian Standard and commonly sold in DIY packs with R values clearly labelled. Easy to cut and install. Remains inert. Should not be compressed or moistened. Butt all ends and edges together firmly.	✓	✓	✓				✓
	Rockwool	Volcanic rock melted at high temperatures and spun into a mat of fine fibres. Denser than glasswool so the R value per unit thickness is higher. Good sound absorption properties. See glasswool for other characteristics.	✓	✓	✓				✓
	Glasswool/ Rockwool— foil attached	Characteristics same as above with foil providing increased insulating value (in summer) and moisture resistance. R value depends on method of installation.	✓	✓					
	Natural wool	Should only be made from new, scoured wool. Must be treated with a vermin/rot proofing agent during the scouring process. Dirt or grease can add to flammability. Some include synthetic (usually polyester) fibres to reduce settling and compression. The Wool Mark logo signifies the batt is made from pure wool only.	✓	✓	✓				✓
	Polyester	Manufactured from polyester strands spun into a mat. Similar physical properties to glasswool and rockwool. Non-toxic, with no known physical or health hazards. Does not burn, but will melt if exposed to a direct flame. Butt all edges firmly.	✓	✓	✓				✓

	Insulating Material	Material Description	Typical Applications						
			Flat Ceilings Pitched Roofs	Cathedral Ceilings Or Raked Ceilings	Timber Floors	Suspended Concrete Slabs	Concrete Slab Edges	Full Masonry Walls	Framed Walls
Boards	Extruded polystyrene (styrofoam)	Rigid boards of close cell polystyrene which retain air but exclude water. High R value per unit thickness. Suitable where space is limited. Easy to cut and install. Should only be used between non-combustible materials such as brick, aluminium and plasterboard. Can be rendered. Most commonly used material for slab-edge and cavity brick wall insulation. Greater structural strength and moisture resistance than expanded polystyrene.		✓	✓	✓	✓	✓	✓
	Expanded polystyrene (EPS)	Semi-rigid boards of white polystyrene beads. High water absorbency. Combustible and should only be used between fire resistant materials. Easy to cut and install. Available as preclad panels. Also used in integrated wall systems.		✓	✓	✓	✓	✓	✓
	Expanded polystyrene —foil attached	Expanded polystyrene boards sandwiched between reflective foil. Characteristics same as above, however, higher R values achieved due to the addition of two reflective surfaces and higher water resistance.		✓					✓
Loose Fill	Cellulose fibre	Manufactured from waste paper pulverised into a fine fluff. Fire retardant added. Generally pumped into the roof by contractor. Difficult for the purchaser to ensure uniform thickness and density if installing by hand. Product should be manufactured to AS2462 and installed in a consistent, even layer. Must be kept dry. Must not be compressed. Settling of up to 20 mm per 100 mm thickness may occur, decreasing performance.	✓	✓					
	Granulated rockwool	Properties as per rockwool batts. However, material is loose, not a prefabricated mass. Treated with a water repellent. Should be installed in an even, consistent manner.	✓	✓				✓	✓
	Natural wool	Made from off-cuts of natural sheep's wool. Quality and density can vary considerably, affecting the R value. Other characteristics same as for natural wool batts.	✓	✓					

	Insulating Material	Material Description	Typical Applications						
			Flat Ceilings Pitched Roofs	Cathedral Ceilings Or Raked Ceilings	Timber Floors	Suspended Concrete Slabs	Concrete Slab Edges	Full Masonry Walls	Framed Walls
Reflective	Reflective foil	Aluminium foil laminated with glass fibre reinforcement. Supplied in rolls, one side often painted with an anti-glare paint. Does not have a significant R value itself, and requires a sealed air space of at least 25 mm between foil and solid surface to achieve full insulation qualities. Gaps in foil reduce performance. Valuable in combination with bulk insulation for enhancing performance. Useful barrier against transfer of moisture. Reflective surface needs to remain clean and dust-free. Dust build-up reduces R value.	✓	✓	✓				✓
	Concertina foil batts	Expandable concertina folded foil-paper laminate. Can be adjusted to suit varying gaps. Other characteristics identical to laminate bought as rolls.			✓				✓
	Multi-cell foil batts	Prefabricated batts made from layers of laminated foil with partition reflective strips to produce a cell construction with enclosed air cavities. Gaps will significantly reduce performance. Double or triple-cell batts (two and three layers of cells, respectively) may be necessary to achieve adequate winter insulation levels. Dust build-up reduces R value.		✓	✓				✓

	Insulating Material	Material Description	Typical Applications						
			Flat Ceilings Pitched Roofs	Cathedral Ceilings Or Raked Ceilings	Timber Floors	Suspended Concrete Slabs	Concrete Slab Edges	Full Masonry Walls	Framed Walls
Building Material	Aerated concrete	Lightweight concrete blocks or panels aerated to trap insulating pockets of air. Blocks provide solid masonry wall and insulation in the one product. Good thermal and acoustic properties. Non-combustible. Easy to handle. Must be waterproofed with acrylic render and paint system.						✓	✓
	Expanded polystyrene	Hollow forms filled with concrete. Hollow EPS blocks and panels create a solid formwork that is then filled with concrete, or sprayed with an external concrete render. Must be waterproofed with acrylic render and paint system.						✓	
	Insulated panelling	A range of building products incorporating inner and/or outer vinyl, cement or metallic materials rendered onto extruded or expanded polystyrene. Designed to be used as pre-insulated external or internal panelling on roofs or walls or as a replacement for conventional tilt concrete construction. Some manufacturers use polyurethane foam or mineral wool in place of polystyrene. Characteristics vary depending on product.	✓	✓				✓	✓
	Weatherproof housewrap	Sheeting made of polyethylene fibres bonded together by heat and pressure. Added to buildings during construction to weatherproof and draught proof walls.	✓	✓	✓				✓

Bushfire note

The higher the bushfire risk, the greater the caution required in selecting appropriate insulation products.

Some insulation products are non-combustible and non-flamable (e.g. Rockwool) and so are recommended to seal roof/wall junctions for example.

Other products such as reflective foil roof sarking are required to stop embers under tiles and metal sheet roofs.

Depending on your BAL, some insulation products (e.g. polystyrene, polyurethane blocks and panels, PVC) may not be suitable where it could be exposed to heat or flame in external walls See AS 3959-2009.

References

Australian Government (June 2007)
R-Values for Timber Framed Building Elements, Forest and Wood Products Research and Development Corporation.
www.tastimber.tas.gov.au/species/pdfs/Rvalue-Edition-2-Intro-V2.pdf

Insulation Council of Australia and New Zealand (March 2008)
Insulation Handbook Part 1: Thermal Performance.
www.icanz.org.au/handbook

Further information

resourcesmart.vic.gov.au
sustainability.vic.gov.au
www.saveenergy.vic.gov.au
www.buildingcommission.vic.gov.au
www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

Notes

> thermal mass

Included in this fact sheet:

- > Understanding thermal mass
- > How thermal mass works in different seasons and climates
- > Where to place thermal mass
- > Thermal mass in different construction types

This fact sheet explains how thermal mass works and provides guidelines for its location and extent. The effect of thermal mass in summer and winter and the relationship with climate is also outlined.

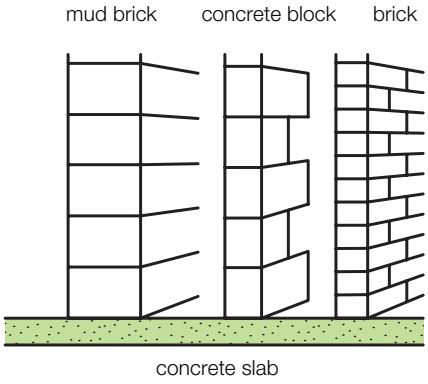


Figure 1: Materials with high thermal storage capacity

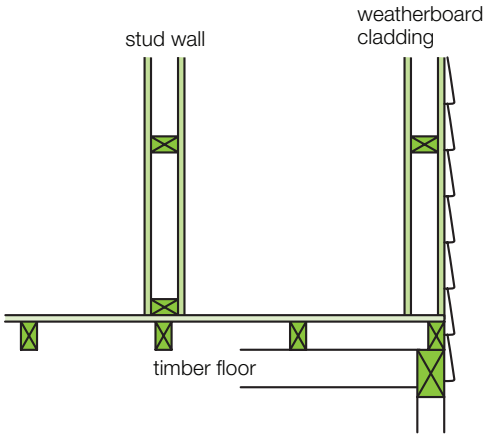


Figure 2: Materials with low thermal storage capacity

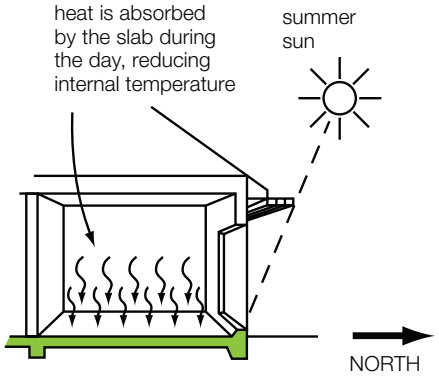


Figure 3: Thermal mass in summer

Understanding thermal mass

Thermal mass is a term used to describe the ability of building materials to store heat (thermal storage capacity). The basic characteristic of materials with thermal mass is their ability to absorb heat, store it and release it later.

Adding thermal mass within an insulated building helps to reduce the extremes in temperature experienced inside the home, making the average internal temperature more moderate year round and creating a more comfortable home in which to live.

Heavyweight building materials store a lot of heat so are said to have high thermal mass (see Figure 1). Lightweight materials do not store much heat and have low thermal mass (see Figure 2).

The use of heavyweight construction materials with a high thermal mass (e.g. a concrete slab on the ground and insulated brick cavity walls) can reduce total heating and cooling energy requirements substantially compared with a home built of lightweight construction materials with a low thermal mass (e.g. brick veneer with a timber floor).

Seasonal effects of thermal mass

Summer

In summer, thermal mass absorbs heat that enters the building. In hot weather, thermal mass has a lower initial temperature than the surrounding air and so acts as a heat sink. By absorbing heat in the home, the internal air temperature is lowered during the day, resulting in increased is comfort without the need for supplementary cooling (see Figure 3 on previous page).

During the night, the heat is slowly released to passing cool breezes (natural ventilation), extracted by exhaust fans, or is released back into the room itself. Inside temperatures at night time will be slightly higher than if there was low thermal mass, however with the cooling night effects, temperatures are still within the comfort zone (unless a long spell of consistently hot days and nights is experienced).

The ability of thermal mass to even out fluctuations in indoor temperatures is illustrated in Figure 4. The solid line represents the air temperature in summer inside a double brick house with a concrete slab floor. The dashed line represents the air temperature inside a lightweight timber building. Note that the temperature variation in the brick house is much smaller and that the temperature is almost always within the comfort zone.

Winter

In winter, thermal mass in the floor or walls of a house absorbs radiant heat from the sun through north, east and west-facing windows. Once the sun passes, the heat is gradually released back into the room as the air temperature drops. This maintains a comfortable temperature for some time, reducing the need for supplementary heating during the early evening (see Figure 5).

For good winter performance, thermal mass should be exposed to direct sunlight and is best located in areas with unobstructed north-facing windows.

An additional benefit is that some of the heat from lengthy periods of internal space heating can be stored in the thermal mass. Long after the heating is turned off, the slow release of heat from the walls or floor will help maintain comfortable internal temperatures.

Negative winter effects

In some cases, thermal mass can actually increase winter energy requirements. Where there is little possibility of solar gain, either because north windows are too small or are overshadowed (poor solar access), the benefits of thermal mass will be minimal. Each time supplementary heating is used, the thermal mass needs to be heated before the air temperature rises, which actually increases the heating energy needed. Increasing the area of north-facing glass can help offset this effect.

Consequently, rooms on the southern side of the house will benefit from higher insulation levels and fewer or smaller windows.

Over a year the benefits of thermal mass will outweigh any negative winter effects, resulting in a net increase in comfort and a net reduction in energy consumption for heating and cooling.

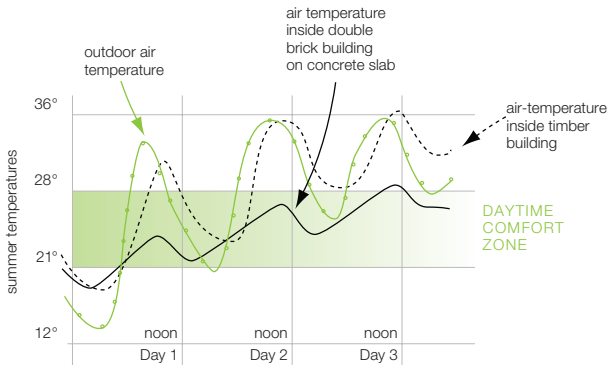


Figure 4: Comparing summer temperatures for buildings of different thermal mass

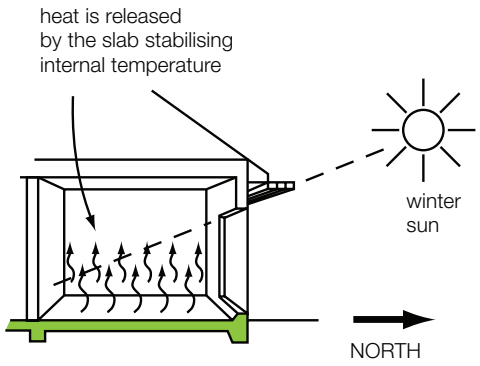


Figure 5: Thermal mass in winter

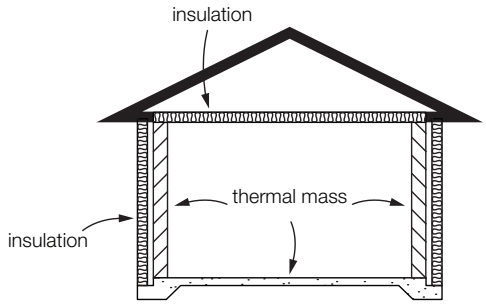


Figure 6: Thermal mass within the insulated envelope

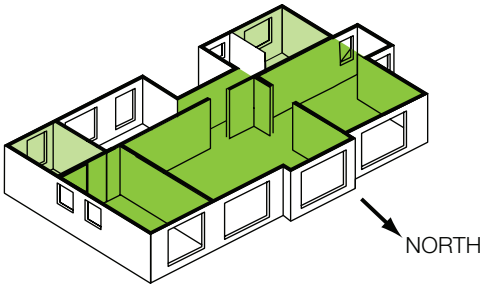


Figure 7: Solar radiation directly onto masonry walls and/or slab

Thermal mass and climate

Thermal mass is particularly effective in places where there is a big difference in the maximum day temperature and the minimum night temperature. In general, the greater the daily temperature range, the more thermal mass required.

North of the Great Dividing Range

The climate north of the Great Dividing Range is different to that south of the Divide.

On average, northern areas have a hotter summer, warmer winter and greater day-night temperature range than southern areas. Thermal mass provides greatest benefits in this situation.

South of the Great Dividing Range

For locations south of the Divide, winter comfort is often a higher priority. Thermal mass provides real advantages in comfort terms and energy savings in well insulated homes.

Alpine or mountain areas

In alpine areas or cool climates, thermal mass is less important than insulation and the correct sizing of glass areas. There is less need for thermal mass to moderate summer temperatures, although it is not a disadvantage in winter where heating is operating continuously, provided the building is appropriately insulated.

Locating thermal mass

Inside the insulated building envelope

For maximum effectiveness, thermal mass should be insulated from external temperatures, i.e. should be located within insulated walls. The benefits of thermal mass are considerably reduced if the external envelope is not insulated (see Figure 6). For this reason, brick veneer walls offer little thermal mass benefit, as the brick is on the outside of the insulated cavity. Yet if the materials are reversed ('reverse brick veneer'), the insulation works very effectively to keep the thermal mass warm or cool according to the season (see Figures 6, 14 and 15).

Concrete slab on ground

A concrete floor slab placed directly on the ground will take advantage of the huge thermal mass of the earth beneath.

Inside north-facing rooms

Using thermal mass in north-facing rooms should be a priority, particularly on walls that receive direct winter sun. As the area of north-facing window increases, more internal thermal mass is required to maintain a stable temperature (see Figure 8).

Hot rooms during summer

Locate thermal mass throughout the dwelling for summer comfort, but particularly in north, east and west-facing rooms (see Figure 9). Shading of the windows to these rooms is also very important.

Masonry fireplaces on internal walls

Masonry fireplaces are best located on internal rather than external walls so that the chimney can radiate additional heat into the rooms (see Figure 10).

Amount of thermal mass

High levels of thermal mass are beneficial throughout Victoria, with the exception of alpine areas and some situations where solar access is poor. While technical studies often recommend certain percentages of thermal mass for different construction types and climate zones, in practice most homes have thermal mass provided in only the following few locations:

> floor: concrete slab
> external walls: double brick/masonry or reverse brick veneer
> internal walls: masonry.

Of all the material choices, the wall selection accounts for about 60–70% of the thermal mass of the building, with the floor area accounting for about 30–40%.

Generally, the more thermal mass the better (with good window orientation and insulation). A double brick or masonry home on a concrete slab offers the highest comfort benefits and energy savings. However, the cost of heavyweight materials can outweigh the value of energy savings. For this reason, use as much thermal mass as you can afford to achieve comfortable indoor conditions.

In most cases, give first priority to provision of a concrete slab (substantially less expensive than masonry walls) and supplement this with heavyweight walls if your building budget permits.

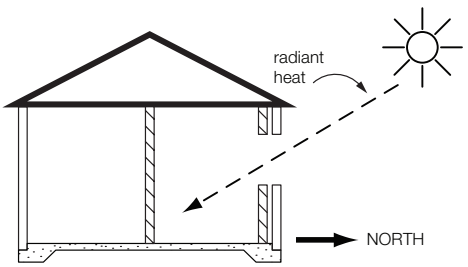


Figure 8: Locate thermal mass in north-facing rooms

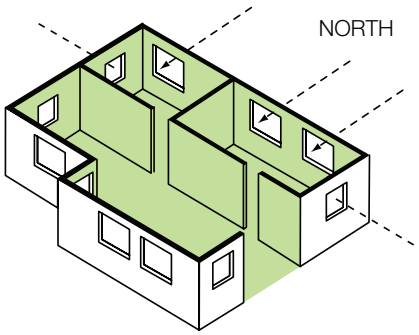


Figure 9: Use thermal mass in rooms that may overheat in summer

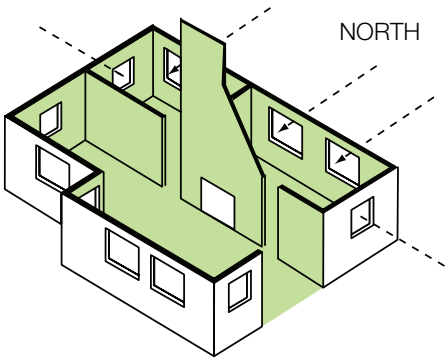


Figure 10: Fireplaces on internal walls

The effect of floor coverings, colour and texture

Surface colour and texture affect the heat absorption of thermal mass.

Floor finishes

Carpets, timber or cork laid over concrete slab floors tend to insulate the thermal mass of the slab from incoming heat. This delays its entry but also slows down its release. The net result is a temperature rise of 1–2°C, which is good in winter, but not so good in summer. This effect partly offsets the winter disadvantage of increased heating energy requirements due to absorption of heat by the thermal mass.

So, while carpet lowers winter energy consumption, it increases summer energy requirements. Figure 11 compares the effect on energy use of carpet and ceramic tiles on a concrete slab.

	Slab Floor Covering	
	Carpet	Ceramic Tiles
Heating	28.8	29.3
Cooling	11.3	6.0
Total	40.1	35.3

Figure 11: Effect of floor coverings on energy consumption (GJ)

A concrete slab floor increases the thermal mass of the floor and its ability to store heat. This can improve cooling in summer (providing the windows are shaded) and works best for rooms with good north solar access. Other hard floor finishes, such as slate and vinyl tiles, have a similar effect on thermal mass performance.

Colours, textures and wall surfaces

Thermal mass that is darker in colour, has a hard surface and a textured, dull finish absorbs more heat than lighter coloured material that is soft and has a glossy or polished finish. Depending on the characteristics of the thermal mass this could result in significant differences in its ability to moderate the internal temperature of a home (see Figure 12).

The improved thermal storage of dark, textured solid walls should be balanced against the negative effect of such walls on internal light levels. Light-coloured reflective surfaces maximise both daylight and artificial light, whereas dark surfaces absorb light.

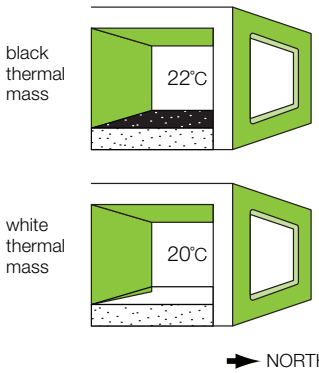


Figure 12: Comparison of the effect of colour on room temperature

Special construction types

Mud brick

Mud brick and rammed earth homes generally have thick walls (approximately 300 mm) and high thermal mass. When outside temperatures fluctuate above and below comfort temperatures, the high thermal mass of mud bricks considerably reduces heat transfer, performing particularly well in summer. In winter, however, outside temperatures are normally lower than comfort temperatures and the low thermal resistance of mud brick leads to poor winter performance as heat is lost through the walls.

Approximately six times as much heat passes through a mud brick or rammed earth wall compared with an insulated brick veneer wall. To reduce heat losses in winter, it is advisable to install external insulation to mud brick or rammed earth walls (see Figure 13). Avoid fixing insulation to the internal face as this reduces the thermal mass benefits of earth walls.

Due to the winter performance of this type of construction, careful design is required to achieve a 5-star thermal performance rating. Involving a thermal performance assessor at the design stage of a home will ensure good thermal performance year round.

Reverse brick veneer

Reverse brick veneer, as the name suggests, puts the brickwork on the inside and timber framing on the outside i.e. the reverse of traditional construction. This form of construction enables a timber-style home to achieve the same level of thermal performance as a double-brick home.

By reversing the traditional construction type, the high thermal mass of brickwork can be used to great advantage. Instead of being on the outside of the insulation and hence isolated from the room, the brick skin is within the insulation envelope. Reverse brick veneer can be used in conjunction with either a concrete slab floor (see Figure 14) or a timber floor (see Figure 15).

Reverse brick veneer does not have to be used for the entire home – sometimes it is only used for north-facing rooms. The external skin can be any type of lightweight cladding suitable for exterior use. In bushfire zones, material selection will depend on the BAL.

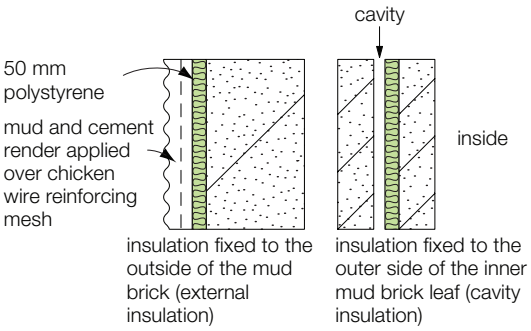


Figure 13: Insulating mud brick walls

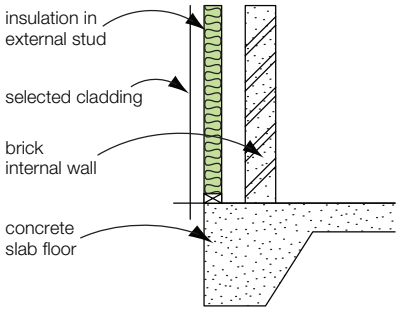


Figure 14: Reverse brick veneer on concrete slab

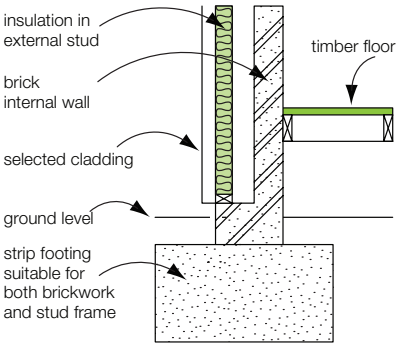


Figure 15: Reverse brick veneer with timber floor

Two-storey dwellings

The upper storeys of homes have the potential to overheat in summer as they are usually of lightweight construction, with either brick veneer or weatherboard walls.

To prevent overheating, upper levels should incorporate as much thermal mass as possible, as well as providing ventilation and breeze pathways.

Thermal mass can be provided by a suspended concrete slab floor, internal brick walls, the continuation of ground-floor double-brick construction, or any other technique that builds concrete or masonry into the structure.

Windows to the east and west should be avoided or minimised because they can cause overheating. Limit the upper-storey window area to the north at less than 10% of the gross upper floor area. All windows should be effectively shaded and positioned to allow good cross-ventilation.

Bushfire safety considerations

All styles of homes can meet bushfire requirements with the appropriate material selections, but homes with higher thermal mass will enhance comfort and provide greater bushfire safety.

Check with AS 3959-2009 to be certain.

Further information

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sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

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ENV015 2.05 July 2009

Sustainability victoria

Victoria The Place To Be

> draught proofing and ventilation

Included in this fact sheet:

- > The cost of draughts and air leakage
- > Benefits of controllable ventilation
- > Sources of air leakage and draughts
- > Sealing out draughts and air leakage
- > Good natural ventilation design

This fact sheet is about how the control of air movement can save you both energy and money. It outlines measures that can be taken to reduce air leakage and provides tips for designing controllable ventilation and maintaining acceptable air quality. These steps need to be balanced against bushfire risk at certain times of the year.

Controlling air movement can save energy

The control of air movement – achieved through reducing air leakage and installing controllable ventilation – can help minimise the need for supplementary heating and cooling around your house. In turn, this will deliver provide substantial savings on heating and cooling costs, and improve your comfort levels.

Air leakage has a significant impact on thermal performance. Draught proofing your home (whether it is new or existing) will prevent heat loss in winter, reducing your heating costs, and prevent the entry of warm air in summer, reducing the need for cooling.

Ventilation should be also be planned to cool your home in summer, and reduce or eliminate the need for mechanical air conditioning.

Controllable ventilation can be simply and inexpensively incorporated into the house design, allowing fresh air in when necessary. Units with appropriate seals or louvres can also prevent heated air from escaping and cold air from entering the home. Forced ventilation systems such as exhaust fans and rangehoods can be used to avoid problems of odour and condensation.

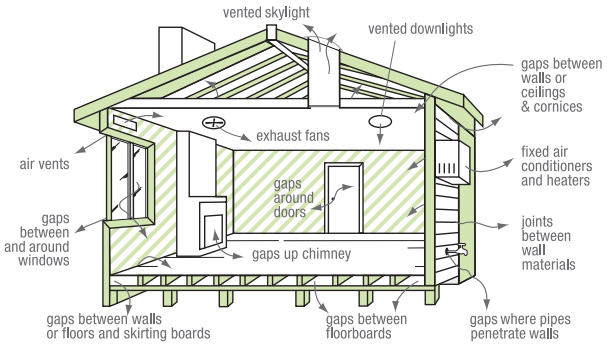

Figure 1: Major sources of heat leaks and draughts

Preventing air leakage and draughts

Around your house, air leakage can result from:

- > infiltration – the uncontrolled entry of outside air through structural gaps, window and door openings, exhaust fans, vented downlights and fixed wall vents
- > exfiltration – the loss of air from inside the home indoors by the same means.

Find out more at resourcesmart.vic.gov.au

Figure 2: Air leakage sources and recommended solutions

Source of air leakage	Solution
Door and window openings	> Standard doors and windows are available with weatherstrips already fitted – their use is recommended. Alternatively, if these cannot be used, seal gaps around doors and openable windows with lightweight self-adhesive weatherstripping products (foam, flexible plastic, polypropylene pile strips) – but note requirements for bushfire resistance. > Fit draught excluders to the bottom of all external doors (required for all BAL) and to internal doors leading to unheated and vented areas (Figure 4). > Fit automatic door closers to external doors and doors leading to unheated areas. > Avoid the use of cavity sliding doors, which are hard to seal.
Construction joints	> Use expandable foam products to seal cracks and gaps between building components, such as the junction of window and door frames, walls, floors and ceilings, skirting boards, plumbing pipes, exposed rafters and beams, inbuilt heaters and air conditioners, and between masonry walls and timber framing (see Figure 5). But note that bushfire requirements limit external gap sizes to 2 – 3 mm.
Open fireplaces	> Victorian insulation regulations require dampers to be fitted to all new fireplaces – these should be closed when the fireplace is not in use. There are two basic types and both prevent the entry of rain and insects (see Figure 7); - type A fits on top of the chimney and is controlled from inside with a chain and handle - type B sits in the throat of the chimney, giving more control and reducing heat wastage up the chimney, but is more difficult to install in existing fireplaces.
Vented skylights	> Avoid using permanently vented skylights in any new construction or in heated areas. > Use a diffuser at ceiling level for skylights to prevent heat conduction and convection creating cold draughts. In bushfire zones, the diffuser may have to be safety glass (not plastic).
Exhaust fans	> Select self-closing models (automatic shutters or dampers) to stop air leaks, and always vent exhaust fans and rangehoods to the outside, not into the roof space or wall cavity where moisture may condense and damage wall or ceiling linings (see Figure 6). > For existing fans, fit a lid over the outlet. The lid blows open when the fan is switched on and falls shut when the fan stops. Products are also available to seal non-self sealing exhaust fans. In bushfire zones, seek out metal external covers rather than plastic.

Source of air leakage	Solution
Recessed down lights	> These can cause air leakage to the roof space and compromise insulation. > In existing buildings, these can be replaced with surface-mounted light fittings, non-vented recessed fittings or vented recessed fittings that use a backing cap around the fitting in the roofspace. > Avoid use in new construction.
Duct outlets	> Provide dampers or covers to outlets when not in use. Lids that open when in use and fall closed when not in use can also be used to cover outlets. > Roof-mounted evaporative coolers should be sealed or covered over the heating season (if not in use). These are not permitted in higher BALs.

Most buildings leak air around windows and doors and through construction gaps. When the wind blows, a pressure difference is created between inside and outside. This causes some outside air to be forced into the home on the windward side (infiltration) and some inside air to be sucked out on the leeward side through gaps in the structure (exfiltration), as shown in Figure 3.

Air leakage can be minimised by careful attention to design, detailing, specification and construction.

Some typical sources of air leakage, with recommendations for improvement are shown in Figure 2.

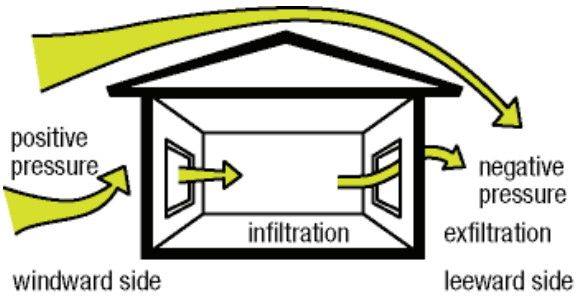

Figure 3: Infiltration and exfiltration

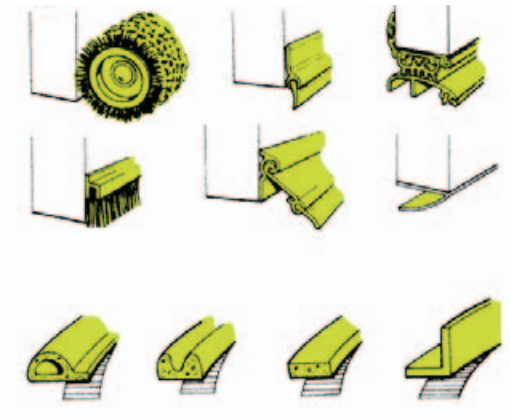

Figure 4: Draught excluders, of which only some are suitable in bushfire zones

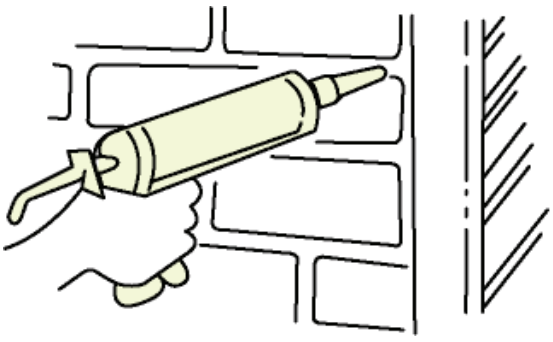

Figure 5: Seal around construction joints

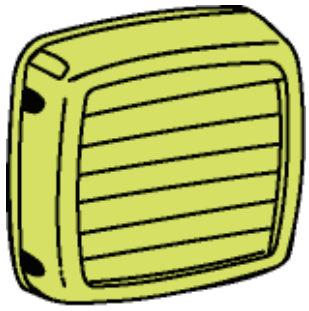

Figure 6: Self-closing exhaust fan - metal louvres or perforated mesh over may be required in high bushfire zones

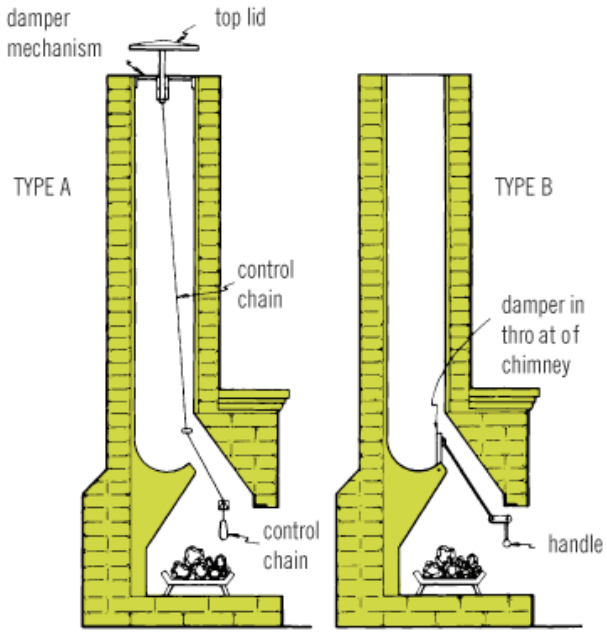

Figure 7: Chimney dampers

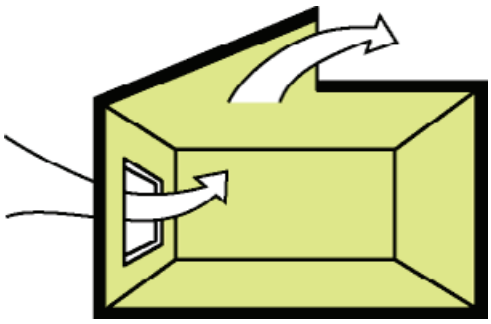

Figure 8: Cooling by convection flow

Ventilation

Ventilation is the deliberate replacement of inside air with outside air by utilising naturally-occurring air temperature and pressure differences, or by the use mechanical means such as exhaust fans.

When the air moves faster than the speed of natural air leakage, ventilation has a cooling effect on the human body. At air speeds of 0.5-1.0m per second, the body will feel 2-3° cooler in 25°C air.

The greater the extent of air-tightness to eliminate draughts and reduce energy costs, the more important it is to provide controlled ventilation to maintain adequate air quality, particularly in service areas such as kitchens and bathrooms. Controllable ventilation, such as exhaust fans that close off when not in use, provide ventilation when required without contributing to overall air leakage.

More recently, specialised mechanical heat recovery ventilation systems have become available. These work in conjunction with central heating/cooling units, and provide control of ventilation and humidity levels.

Openable windows and doors and the interior layout can be planned to take advantage of natural breezes and convection flow. Fans can be used where natural ventilation is inadequate, or where the rapid removal of air contaminants is required.

Types of ventilation and how they cool your home

Cross-ventilation

Cross-ventilation uses differential wind pressure. In other words, when the air outside is cooler, windows on opposite sides of the home can be opened. Cool air enters on the windward side and passes out on the other side, replacing warm inside air with cool outside air.

Exhaust fans

Ceiling and roof-mounted exhaust fans can be used to extract warm air, creating a pressure imbalance that will draw cool air from outside via open windows or doors to replace the warm inside air (see Figure 9). Powerful 'whole-house' fans, which can move large volumes of air quickly, are also available. Only fans with dampers, auto-closing louvres or vent covers should be used. Such fans use very small amounts of electricity. In higher bushfire zones, external vents from exhaust fans must have protective screening with openings no more than 2 or 3 mm.

Ceiling fans

Ceiling fans can provide additional air movement in summer if the ceiling height is adequate (see Figure 10). Overhead fans circulate large volumes of air and encourage evaporative heat loss from the body. They are an economical and efficient way of creating cool breezes. In hot summer conditions, increased air movement can raise the body's tolerance threshold for high temperatures by about 3°C. In winter, if able to be reversed and slowed, they can spread warmth around a room or space.

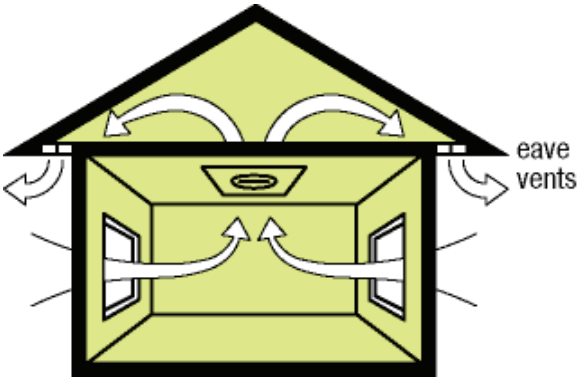

Figure 9: Cooling with ceiling exhaust fan

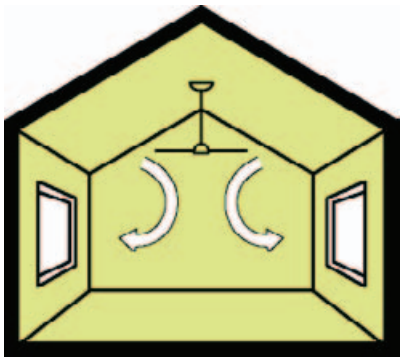

Figure 10: Cooling with ceiling fan

Designing good ventilation

Determine where the natural breezes come from

The direction of prevailing winds for each month can be sourced from the Bureau of Meteorology. Consider the usual direction of cooling breezes.

Determine how local conditions modify the direction of the breeze

Valleys and large land masses can direct or deflect wind away from prevailing paths. Buildings, tree belts or other tall features can cause wind shadows, or pockets of fairly still air. Such obstructions can block ventilation and should be taken into account when designing your house. The same features can be used to minimise your bushfire risk. Wind shadows between the obstruction and the immediately adjacent building are created for a distance of about three to seven times the height of obstruction (see Figure 11).

Locate and determine the size of openings that will admit cooling breezes

Allow for an inlet and outlet opening on opposite sides of the home, both linked by a short unrestricted path. With an inlet only opened, the air speed inside the building will be only 4% of that on the outside (see Figure 12).

With both an inlet and outlet opening of the same size, the inside air speed will be around 35% of the prevailing wind speed outside. The opening on the leeward side should be equal to, or bigger than, the inlet on the windward side. Increasing the size of the outlet should result in an inside air speed that is approximately 44% of the outside speed, enhancing its cooling effect (see Figure 13).

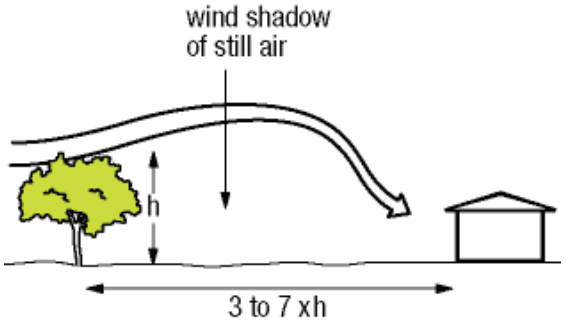

Figure 11: Wind shadow

Plan the interior so that air can flow freely

The more direct the path for air to move through a building, the greater its speed and cooling. Partitions and openings should be carefully planned to ensure that pockets of still air are not created (see Figure 14). Passages that have openings to the outside can create paths for air movement to adjoining rooms.

Air quality

A completely airtight home without controllable ventilation is not desirable, as a minimum level of ventilation is necessary to replace used internal air that contains odours, carbon dioxide, water vapour and contaminants.

Indoor air quality depends on the activities, furnishings and building materials of the home (all of which may produce air contaminants) as well as the degree to which these contaminants can escape. Many building materials and household goods can emit chemicals which dissipate over time. The recommended minimum air exchange of 0.5 air changes per hour is, however, not adequate for the complete removal of contaminants in all situations, and should be supplemented with controllable ventilation devices, such as openable windows and exhaust fans. High levels of fixed ventilation waste energy and should be avoided.

Heaters that burn internal air (e.g. solid fuel and some gas heaters) can be provided with a separate external air supply to avoid draughts and maintain indoor air quality. These require a damper to be closed off when not in use (see Figure 15). Ventilation is essential when using un-flued LPG heaters. For situations where additional ventilation at a higher air change rate is required at some times, you will need to:

> provide openable windows that increase ventilation only when needed
> use self-closing wall or ceiling exhaust fans, vented externally, for rapid removal of cooking fumes, odours or steam from the laundry, kitchen or bathroom
> locate fans near the source of the contaminant, e.g. an exhaust fan near the shower.

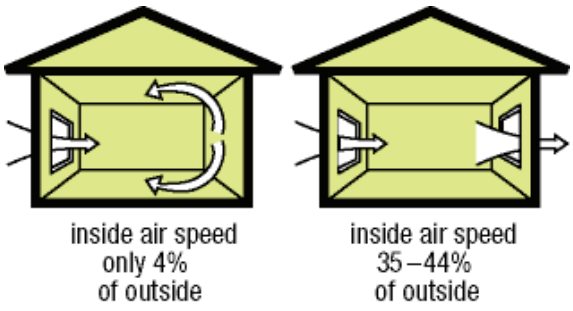

Figure 12: Inside air speed with cross-ventilation

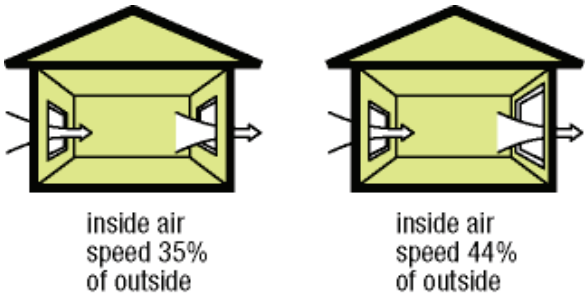

Figure 13: Relative window opening sizes

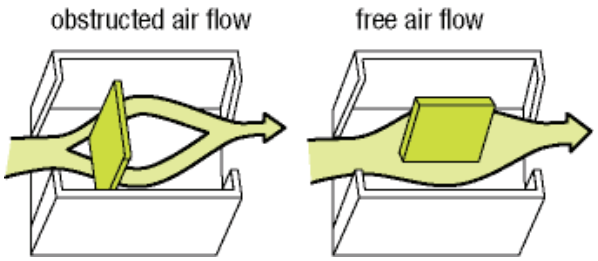

Figure 14: Air flow

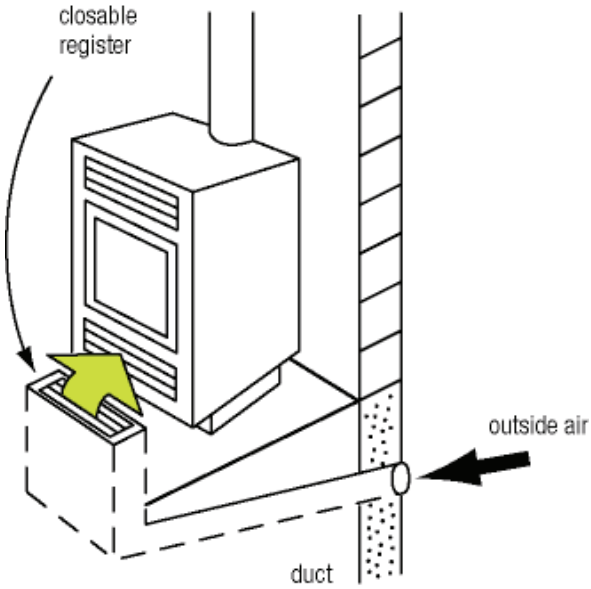

Figure 15: Separate air supply for some heaters

Bushfire note

At times of bushfire risk, close windows and doors to protect your home from radiant heat, winds and embers.

Fixtures that penetrate walls and roof should be non-combustible and sealed, especially in higher BAL zones.

Check with AS 3959-2009 to be certain.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

www.yourhome.gov.au

www.bom.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

> material selection

Included in this fact sheet:

- > **Choosing environmentally preferred materials**
- > **Design considerations when selecting materials**
- > **Labelling schemes make your choice easy**

The aim of this fact sheet is to provide food for thought when you are selecting building materials for your new home. Here you'll find information on the benefits of choosing environmentally friendly materials, design considerations, environmental labelling schemes, and environmentally friendly options.

Think before you act

As consumers, we make choices everyday based on many different factors including quality, brand name and cost. But the choices we make also have an impact on the environment – whether it's choosing to walk to the local shop rather than drive, or to use a green reusable bag rather than a throw-away alternative.

When choosing materials for your new home, careful consideration should also be given to products and materials that have a reduced impact on the environment and that provide a healthier indoor environment for you and your family to enjoy.

Buildings consume 32% of the world's resources, including 12% of its fresh water and up to 40% of its energy.

Buildings generate 40% of waste to landfill and 40% of air emissions.

Source: Green Building Council Australia

Environmental issues to consider when choosing materials for your home

When choosing materials for your new home, bear in mind the following issues:

- > raw resource extraction has an impact on our physical environment – for example, tropical forests may be cut down for window or flooring timbers such as Merbau
- > the production of some materials depletes non-renewable resources, including oil, or can cause water pollution
- > the manufacture, use and transport of materials inevitably leads to greenhouse gas emissions, however, some materials have more of an impact than others. For example, steel requires more energy to manufacture than timber. Likewise, locally sourced materials create fewer transport emissions
- > some materials (such as solvent based paints) are toxic to indoor environments, while others like asbestos are both a danger to health and a problematic landfill burden.

Bushfire issues when choosing materials

The new requirements for building in bushfire prone areas includes material requirements for walls, roofs decks, verandas and the like. This reflects the increasing knowledge of how materials perform under bushfire conditions. Hence the AS 3959-2009 specifies those materials acceptable for the different BAL zones. You'll need to carefully check the requirements that will apply to your property.

- > The strictest requirements apply to the 400 mm above the ground, above decks or above flatter roofs (eg, attached carport or lower roof) - where burning embers can collect.

Find out more at resourcesmart.vic.gov.au

> Understandably, non-combustible materials (eg. bricks, blocks, mudbrick, concrete, AAC, metal) most easily meet requirements within most BAL.
> The Standard accepts fibre-cement (6 mm, 9 mm) in low to high risk areas.
> A wide range of Australian hardwood timbers may be used in low to medium risk areas, becoming more restrictive in species with higher BAL zones (all of which are listed in the AS 3959-2009 Appendices E and F).
> Within 'Extreme' and 'Flame Zone' BAL in many case the materials must be tested to another Australian Standard 1530.8 parts 1 or 2, before being accepted in these highest risk areas.

There's also many other details to consider with materials in bushfire zones. Smooth materials will not capture and hold embers like rough materials and ledges, window and door sills, wall ventilators, penetrations for pipes etc. all are vulnerable points that must be actively considered.

Manufacturers and industry groups are progressively testing their products to suit BAL zones, so you may need to check compliance directly with them.

Design considerations

When selecting materials for your home, you should also take design considerations into account, including:

> Does the material require long-term maintenance?
> Will the material contribute to better health and comfort in your home?
> Does the material provide flexibility to accommodate changes over time?
> Can wastage be avoided by considering material dimensions during the design stage?
> Is the material durable and does it have the potential for reuse?

As well as environmental impacts, which are often hard to locate or quantify, your choice of material can also have significant health impacts. These include:

> emissions from products polluting indoor air over many years
> short term, high-level emissions during construction (such as when painting)
> groundwater contamination from contaminants leaching out of landfill.

How environmental labelling schemes make it easier to choose

It's a confusing business finding and comparing products or materials that have a reduced impact on the environment or that offer health advantages. To help consumers with these issues, a number of labelling schemes have been developed to certify products and materials that meet standards of environmental, quality and social performance. These schemes are designed to help you recognise which materials have preferable environmental outcomes.

The labelling schemes include:

The Good Environmental Choice Label

The Good Environmental Choice Label is the only environmental labelling program in Australia that indicates the environmental performance of a product from a whole-of-product-life perspective.

The label is awarded to products that meet voluntary environmental performance standards that have been created and assessed in line with international environmental labelling standards

Australian Forest Certification Scheme (AFCS)

The Australian forest industry has recently developed the Australian Forestry Standards (AS 4707, As 4708) to promote sustainable timber harvesting and management. Over 8.7 million hectares of forest are managed under this scheme, which includes 'chain of custody' and sustainable land management practices.

Forestry Stewardship Council (FSC)

The Forestry Stewardship Council is an independent, non-governmental, not-for-profit organisation established to promote the responsible management of the world's forests.

The FSC label provides a credible link between the responsible production and consumption of forest products, enabling consumers and businesses to make purchasing decisions that benefit people and the environment, as well as providing ongoing business value.

EcoSpecifier

EcoSpecifier provides a guide to the selection of individual materials on an 'environmentally preferred' basis. EcoSpecifier explains how materials are assessed as being environmentally preferred based on lifecycle assessment and a range of other factors. It includes a comprehensive list of environmentally preferred generic materials commonly used in Australia. Use this tool to select materials with the least environmental impact.

Environmentally preferred options

> Consider materials with low toxicity (such as low VOC paints or composite wood products with low formaldehyde content). These products will provide better indoor air quality and are healthier products for your tradespeople to use.

> Consider the use of recycled materials such as salvaged timber or slag (a by-product of iron and steel making) in concrete. This also reduces the embodied energy of the concrete.

> Consider materials that have a low embodied energy (the energy required to extract, manufacture and transport the material).

> Use locally sourced materials and local tradespeople where possible.

> Look for materials and products that have the potential to be re-used – for example. steel, concrete and timber can all be recycled and re-used.

> Look for products with long warranties, as this can be a good indicator of their longevity.

What are the benefits of environmentally preferred materials?

By incorporating low impact materials in your new home, you can significantly reduce its environmental footprint by:

> reducing the embodied energy of your house
> ensuring that timbers from threatened tropical rainforests are not used
> minimising the health impacts of glues, sealants and paints on contractors
> encouraging the use and development of products incorporating recycled content, driving increased recycling and reuse throughout the supply chain
> avoiding the use of problematic chemical preservative compounds that may have health impacts or discourage the future reuse and recycling of materials.

Further information

www.yourhome.gov.au

www.geca.org.au

www.fscaustralia.org

www.ecospecifier.org

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 2.07 July 2009

Sustainability victoria
Victoria The Place To Be

> measuring your home's energy efficiency

Included in this fact sheet:

> 5-star requirements
> Rating tools
> Thermal performance assessors
> Beyond 5-star: doing more than the minimum

This fact sheet explains all about the 5-star requirements for new homes and how you can achieve this through smart design. There is also information on how houses are rated, finding an assessor and what you can do if you wish to go beyond 5-star performance.

5-star regulations for new homes – what it means for you

Since July 2005, all new houses and apartments in Victoria must be built to meet 5-star energy efficiency and water management requirements. To reach the 5-star Standard, a building must have:

> 5-star energy efficiency rating for the building fabric
> water efficient taps and fittings
> either a rainwater tank for toilet flushing or a solar hot water system.

For most homes, achieving the 5-star Standard requires just a few simple improvements to a building's standard design and construction. There are many options available, such as increasing the level of insulation, better orientation and exterior shading, better seals and draught-proofing and the use of high performance glazing.

The 5-star Standard is designed to be a flexible way of improving the performance of new homes. This means designers and builders can use their creativity in the design and construction of 5-star homes to meet each homeowner's requirements of being cost-effective, functional and aesthetically pleasing.

A 5-star home's combination of energy and water saving features work together to ensure higher comfort levels for you and your family, and reduced operating costs.

The design process

As part of the building approval process, your building designer or architect will need to ensure your home complies with the 5-star Standard. To do this, they will engage a Thermal Performance Assessor who will assess your home's design using an energy rating tool, which produces the star rating.

An energy or star rating indicates how much energy would be needed to heat and cool the home. The higher the star rating, the more comfortable your home will be and the more money you'll save on energy bills. Higher star ratings also add to the value of your property.

Your designer could also choose to comply with the Deemed to Satisfy provisions in the Building Code of Australia but using this method will not

produce a star rating or give you the opportunity to explore a higher star rating. The most popular method used in Victoria is to engage a Thermal Performance Assessor to produce an Energy Rating Report.

Once you have completed the design process, you will need to get a building permit from your Building Surveyor. They will review the documentation and energy rating to ensure it complies with the 5-star Standard.

Rating tools

Rating tools provide assessment methods and benchmarks that can be used to set minimum regulatory standards and can encourage better levels of practice that go beyond those minimum standards.

The tools used in Victoria include:

> FirstRate 5
> AccuRate
> BERS Pro.

Finding an accredited Thermal Performance Assessor

Accredited assessors are qualified to issue certified ratings of house plans for submission to Building Surveyors and Councils. Sustainability Victoria accredits these assessors to provide energy ratings for houses in Victoria.

Accredited assessors can provide:

> cost effective methods of achieving energy efficiency
> advice on materials and window selection
> advice on how to best operate your new home.

For a full list of accredited assessors, please visit resourcesmart.vic.gov.au/for_households_1923.html. You'll find details of assessors equipped to provide ratings in Victoria, including the software tools they are accredited to use.

Getting the best out of the design process

The rating tools can rate up to 10 stars – the more stars, the more comfortable your home will be and the lower your annual running costs.

To achieve the best possible star rating, ensure your building designer works closely with your Thermal Performance Assessor in the concept design stage. Their early collaboration is essential if you are looking to go beyond the minimum 5-star Standard.

Beyond 5-star – here's how to do more than the minimum

Below is a list of design solutions to help your designer or builder achieve a 6-star or greater rating for your home.

Building envelope

The size of the home's footprint has an impact on the energy outcome. A larger floor plan will require more heating and cooling than a smaller floor plan.

Floors

If selecting a timber floor construction, insulation will be required to minimise heat gain and loss. In bushfire zones, this may need to be fire resistant and/or have further protection.

Walls

Minimum R-2.5 insulation and anti-glare foil specified for walls.

Ceilings

Provide a mixture of reflective foil below the roofing material and R4 insulation in the ceiling to combat seasonal variations.

Windows

Window selection will play a major role in achieving a 6-star rating. The priority in Victoria's climate is to retain heat in the home and maximise the use of 'free' solar energy in winter. The orientation, size and material composition of your windows will play a major role in this.

> High efficiency window frames and glazing will be required in most cases where the total window area is more than 25% of the floor area.
> Maximise north-facing windows to allow the winter sun in and provide a source of free heat.
> Minimise south, east and west facing windows.

Windows with at least four heating stars (under the Window Energy Rating Scheme WERS) suit a heating climate, such as Victoria, and make the most of the winter sun. Important considerations include:

> to the north, windows should be shaded in summer by correctly sized eaves to minimise heat gain
> east and west-facing windows are harder to effectively shade
> install windows with 'seals' (rubber or foam strips) in the part of the window that opens. These stop heat from escaping in winter or entering the house in summer
> double glaze windows to maintain internal air temperatures
> select timber, aluminium improved or thermally broken window frames to help minimise heat loss or gain
> note that in bushfire zones your selection of glass, materials and seals must conform to your BAL.

Thermal mass

> Provide a form of internal thermal mass heated by direct winter sun (and shaded in summer with correctly sized eaves). Thermal mass affects the temperature within a building by providing a heat source and heat sink surfaces for radiative, conductive and convective heat exchange processes, and providing a time lag in the balance of external and internal temperatures.

> Consider internal mass walls such as brick, concrete or rammed earth.

> If installing a concrete slab, consider exposing the surface to better exploit its thermal mass.

Air leakage and ventilation

> Fit draught excluders to the bottom of external and utility doors to stop heat from escaping under the door in winter or getting into the house in summer, and to meet bushfire requirements.

> Install exhaust fans that can be closed when they are not being used (you shouldn't be able to see through the fan to the outside or into the roof when the fan is switched off). They may need to be metal or covered with protective mesh in some bushfire zones.

> Provide excellent cross-flow ventilation to purge built-up heat in the summer. Cross-flow ventilation works best when windows on the south and southwest capture cooling winds to flow freely through the home and remove built up heat.

> In two-storey homes, allow cooling breezes to flow up and out in summer – but close this down in winter.

Lighting

> Avoid downlights as these require venting to allow built up heat to escape, which means leaving gaps in your insulation.

Bushfire safety considerations

Many of the steps for improved energy efficiency may also enhance the bushfire safety of your home.

However, AS 3959-2009 requires particular materials and building systems within bushfire prone areas.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.buildingcommission.vic.gov.au

www.yourhome.gov.au

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ENV015 2.08 July 2009

Sustainability victoria

Victoria The Place To Be

Appliance efficiency

Victoria
We will rebuild

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> energy and water labelling

Included in this fact sheet:

> Understanding the star labelling system
> Electrical appliance labelling
> Gas appliance labelling
> Water labelling
> Calculate how much you will save

Energy labelling

When looking to buy an appliance, many people compare the size, features, price and running costs of different models. Energy and water efficiency are increasingly important factors in many consumers' purchase decisions.

For electrical appliances, the Energy Rating label acts as an indicator – showing you how energy efficient the appliance is and how much electricity it uses to run each year (except for air conditioners, which are based on energy use-per-hour rather than annual rate).

For gas appliances, the Energy Rating label also provides useful information – showing potential buyers how energy efficient the appliance is and how much gas it uses to run each year.

By understanding how energy labels work, you will be able to make a more informed choice about the relative advantages and disadvantages of different models.

Electrical appliances

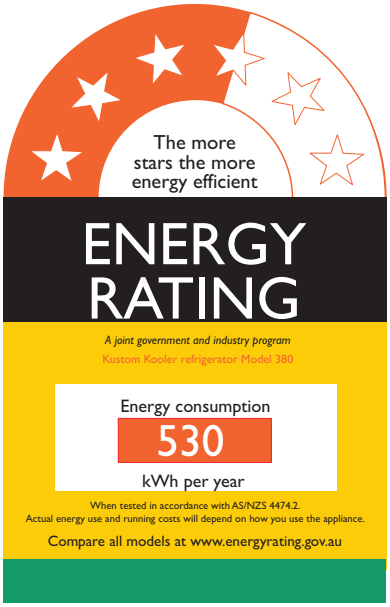

Figure 1: sample electrical appliance energy label

Models of similar size with the same star rating can still have considerably different energy consumption because each star covers a fairly wide range. So, it is important to look at the stars first and then compare the figures in the energy consumption coloured boxes.

Which electrical appliances carry an Energy Rating label?

The following categories of domestic electrical appliances are required to carry Energy Rating labels:

> refrigerators
> freezers
> dishwashers
> washing machines
> clothes dryers
> single phase air conditioners.

Find out more at resourcesmart.vic.gov.au

Key features of the Energy Rating label for electrical appliances

> The Star Rating, which shows the energy efficiency of the appliance on a scale of 1 to 6 stars. The more stars, the more energy efficient it is.
> Half stars are shown – all 6 available stars are shown in the outline.
> The Energy Consumption box, which shows how much energy the appliance uses in kilowatt-hours when tested to the Australian Standard shown on the label.

The Star Rating and coloured band

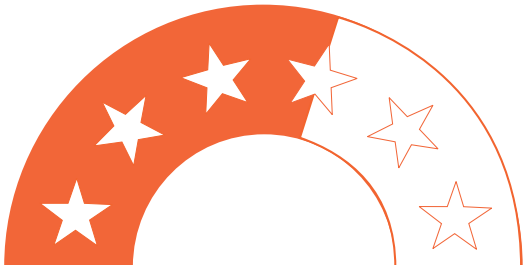

Figure 2: Star rating and coloured band

This gives a quick visual comparison of the model's energy efficiency. The more stars (including half stars) and the further the coloured band extends across the arch, the more energy efficient the appliance.

Comparative energy consumption

For all star-rated electrical appliances (except air conditioners) the Energy Consumption figure is based on the projected annual energy consumption for the appliance (in kilowatt-hours (kWh) per year) based on tested typical use of the appliance in the home.

For air conditioners, it is based on the estimate of energy used each hour (in kWh per hour) of use at a rated capacity for cooling and/or heating, as applicable.

The lower the figure in the coloured box, the less energy the appliance will use and the fewer greenhouse gases will be produced. The Energy Consumption number can also be used to calculate comparative running costs of appliances.

How to estimate annual running costs

To determine the Annual Running Cost of an appliance, simply multiply the Energy Consumption figure in the coloured box by the cost of electricity per kWh (electricity tariff).

Kilowatt hour (kWh): 1kWh = 1,000 watts operating for 1 hour. Your electricity meter reads in this measure.

Energy consumption x electricity tariff = Annual Running Cost

For example, if the Energy Consumption of a refrigerator is 670kWh/year and the average tariff is 17.0 cents per kWh then the Annual Running Cost of the appliance will be:

670 kWh/year x 17.0 cents/kWh = $114 approximately

How to estimate lifetime running costs

To determine a more accurate Lifetime Running Cost of the appliance, multiply the Annual Running Cost by 12, as 10-12 years is the average life cycle of star-rated appliances before they are replaced.

Annual Running Cost x 12 years = Lifetime Running Cost

For example, if the Energy Consumption of a refrigerator is 670kWh/year and the average tariff is 17.0 cents per kWh then the Lifetime Running Cost of the appliance will be:

670 kWh/year x 17.0 cents/kWh x 12 years = $1368 Lifetime Running Cost

Gas appliances

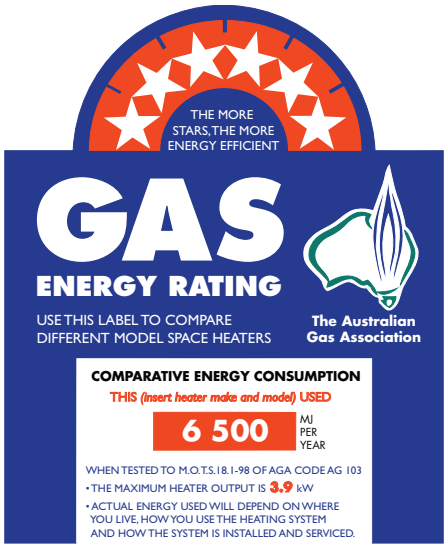

Figure 3: Sample energy rating label for a gas appliance

The Star Rating has been developed to provide you with an easy way of comparing the energy efficiency of different models. It is a simple and fair way of comparing the energy consumption of gas appliances that do a similar job.

The more stars and the longer the red band, the more energy efficient the appliance. An energy efficient appliance uses less gas and is cheaper to run.

Who operates the Energy Rating label system for gas appliances?

The Australian Gas Association is responsible for the administration of the national gas appliance energy labelling program. The gas labelling program is currently voluntary. However, tests required for energy labelling of gas space heaters, ducted heaters and water heaters are part of the specification for safety approval.

This effectively makes the collection of data required to produce a label mandatory, since AGA certification is a requirement in all states.

How do gas appliances get an Energy Rating label?

Gas appliances are tested under Australian Gas Association Codes, which set minimum safety and performance standards and ensure appliances meet the relevant AGA Code requirements for energy labelling.

Which gas appliances carry an Energy Rating label?

Energy Rating labels can be found on:

> gas space (room) heaters
> gas ducted heaters (central heating)
> gas water heaters.

Differences between gas and electricity Energy Rating labels

Though Energy Rating labels on gas appliances may seem similar to the labels on electrical appliances, they should not be compared. The energy ratings on the gas appliances have been tested under different conditions, which make it impossible to compare them with electrical appliances.

Key features of the Energy Rating label for gas appliances

> The Star Rating – this shows the energy efficiency of the appliance on a scale of 1 to 6 stars. The more stars, the more energy efficient it is. Each extra star means that the appliance is 7-10% more efficient than an appliance without the additional star.

> The Comparative Energy Consumption box shows how many Megajoules of gas the unit uses each year (MJ/year). For gas ducted heaters, it tells you how much energy the appliance uses in to heat a cubic meter (m^3) of space each year (MJ/m^3/year).

The Star Rating and red band

Figure 4: Star Rating and red band

Figure 5: Comparative energy consumption box

How to estimate annual running costs

As with electrical appliances, the Comparative Energy Consumption figure (in the red box) can be used as a guide to estimate the typical yearly running cost of the appliance.

Annual Running Cost =
Comparative Energy Consumption (MJ/h)
x gas tariff

Megajoule (MJ/h): energy consumed by a gas appliance per hour.

For example, if a 5-star rated product has a Comparative Energy Consumption figure of 6,500 MJ/year and the average gas tariff for natural gas is 1.0 cent per MJ then the Lifetime Running Costs of the appliance will be:

6,500 MJ/year x 1.0 cent per MJ
= $65 Running Cost

How to estimate lifetime running costs

To estimate the Lifetime Running Cost, multiply the Annual Running Cost by 12 years, which is the average life cycle of an appliance before it is replaced.

Lifetime Running Cost =
Annual Running Cost x 12 years

Gas space (room) heater Lifetime Running Costs

If we assume the space heater has a lifetime of 12 years, the Lifetime Running Cost can be estimated by simply using the MJ/year figure in the red box and multiplying it by the cost of gas in cents per MJ and by 12 years.

For example, if a 5-star rated product has a Comparative Energy Consumption figure of 6,500 MJ/year and the average gas tariff for natural gas is 1.0 cent per MJ, then the Lifetime Running Costs of the appliance will be:

6,500 MJ/year x 1.0 cent per MJ x 12 years
= $780 Lifetime Running Cost

Note: for LPG (bottled gas) the Lifetime Running Cost is calculated in the same way except that the average cost of gas is around 2.0 cents per MJ.

Gas Ducted Heaters (central heaters) Lifetime Running Costs

The Lifetime Running Cost can be roughly estimated by multiplying the MJ/m^3/year figure in the red box by the floor area (square metres) and average ceiling height (metres) of space to be heated, by the cost of gas in cents per MJ.

For example, if a 5-star rated product has a Comparative Energy Consumption figure of 133 MJ/m^3/year, and the floor area of space to be heated is 265 m^2, the average ceiling height of space to be heated is 2.4m, and the average gas tariff for natural gas is 1.0 cent per MJ, then the Lifetime Running Cost of the appliance will be:

133 MJ/m^3/year x 265 m^2 x 2.4m
x 1.0 cent per MJ x 12 years
= $10,150 Lifetime Running Cost

Note: for LPG (bottled gas), the Lifetime Running Cost is calculated in the same way except that the average cost of gas is around 2.0 cents per MJ.

Further information

More detailed information relating to energy labelling can be sourced from: www.energyrating.gov.au

Water labelling

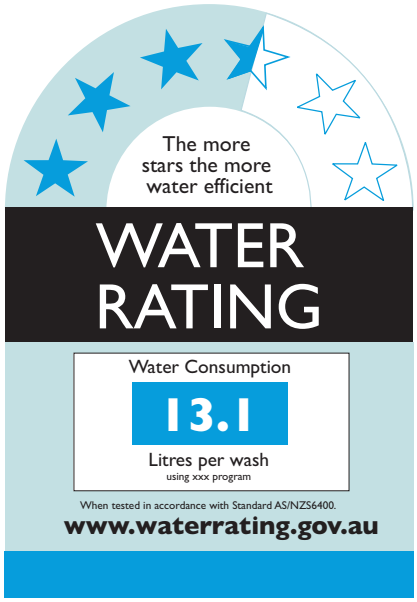

Figure 6: Sample water rating label

The Water Efficiency Labelling and Standards (WELS) water rating label provides water efficiency information for household appliances that use water. It is designed to help you compare products.

The WELS water rating label is similar in appearance to the energy rating label and shows a star rating plus how much water the product uses. The more stars the better.

What appliances carry a Water Rating Label?

The WELS scheme applies to the following whitegoods:

> clothes washing machines
> dishwashers.

Work is underway to extend WELS to other appliances including combination washer-dryers and evaporative air conditioners. The WELS Scheme excludes second-hand products and products imported into Australia for personal use.

Key features of the Water Rating Label

The labels on the different WELS products differ slightly, however all offer two key pieces of information:

> a Star Rating that shows the water efficiency of the appliance on a scale of 1 to 6 stars – the more stars, the more water efficient it is

> a Water Consumption box, which shows the per litre water consumption or water flow – the lower the number the better.

Who manages the Water Rating label?

WELS is administered by the Australian Government through the Department of the Environment, Water, Heritage and the Arts. All State and Territory Governments have a shared commitment to WELS and work with the Australian Government to ensure the integrity and credibility of the scheme.

How do appliances get a Water Rating label?

Manufacturers or importers of WELS products are required by law to register and label them before they are sold in Australia. Before they can be registered, products must be tested to determine their water consumption/flow so that a WELS Standard rating can be applied.

The Star Rating and water consumption/ flow figures on the product label are based on rigorous and independent water efficiency tests. Testing must be done by an approved laboratory, such those accredited by the National Association of Testing Authorities (NATA) or in accordance with the National Appliance and Equipment Energy Efficiency Program.

Further information

More detailed information relating to water labelling can be sourced from www.waterrating.gov.au.

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.01 July 2009

Sustainability victoria

Victoria The Place To Be

> choosing a heating system

Included in this fact sheet:

- > What size to choose
- > Different types of heaters
- > Compare running costs
- > Operate your heater more efficiently
- > Special bushfire considerations

As heating accounts for over half the average household's energy costs, it is important that you think carefully before making a decision on how to heat your home. Making the wrong decision can be a costly and uncomfortable mistake.

This fact sheet can help you to identify your heating needs. It outlines the types of systems available and provides a guide to their running costs, CO_2 emissions and energy efficiency.

A heating package – not just a heater

An energy efficient heating system can save you energy and money, and can help our environment by reducing greenhouse gas emissions.

An effective and economical heating system is more than just a good heater. It should be part of a 'heating package' that should always include:

- > insulating ceilings, walls and floors where possible
- > draught sealing around windows, doors and any other gaps
- > effective window coverings
- > zoning of living and sleeping areas
- > appropriate and efficient heater(s)
- > YOU using your heating package wisely and efficiently.

An energy efficient heating package can use 40% less energy!

Radiant and convective heat

Radiant heat

Radiant heat is emitted from hot surfaces, e.g. the glowing panel of a gas heater, the surface of a heated concrete slab, a bar radiator or open fire. Radiant heat heats objects within the room directly, but does not directly warm the room air.

Radiant heaters are most appropriate if your rooms have large open spaces or high ceilings, or are particularly draughty.

Convective heat

Convective heat is heat that is transferred from one object to another, using moving air or water. Convection heaters work by filling a room with warm air. Fan heaters and ducted heating are examples of convection heaters.

Convection heaters are most appropriate if your rooms are insulated, well sealed against draughts and have average ceiling heights.

They should be avoided in draughty rooms, rooms with high ceilings or areas with open stairwells.

Some heaters combine the effects of radiant and convection heating. Hydronic radiator panels, wood heaters, storage fan heaters and many gas heaters function in this way.

Find out more at resourcesmart.vic.gov.au

Selecting a heating system

Decision 1 – Central heating or space heating?

Firstly, it is important to establish which areas of the home you need to heat, how large the areas are, and how long the areas needed to be heated.

Creating zones in your home can allow you to heat each zone individually, giving you flexibility – the key to energy efficiency.

Heating individual rooms with efficient space heaters, or installing a zoned central system, is preferable to whole house central heating, which heats all rooms regardless of whether they are in use or not.

Work through the first table below to identify the best heating arrangement for your home.

Decision 2 – What size system do I need?

A correctly sized heater is essential for comfort and economy. A heater that is too large will have a higher purchase cost, will not operate efficiently and can create uncomfortable conditions. An undersized heater will not heat the area adequately.

Heaters should be sized to maintain a comfortable temperature in a room on an average cold day in winter. This 'heat load' is determined by room dimensions, insulation levels, window areas and coverings, indoor and outdoor temperatures, etc.

The size of your system should be determined by your supplier. This is especially important when sizing central heating systems.

Decision 3 – What type of heater?

Try to identify those heaters which closely match your heating requirements.

Central heating systems

Central heating systems are large heaters capable of heating most of your home at the one time. To help you control your heating and reduce running costs, all large central heating systems should be zoned.

Central heating systems can also be supplemented by installing a high efficiency space heater in the main living area, to be used when whole house heating is not required.

If you need to heat …	
Only living zones	Use one or more high efficiency space heaters
Living areas for long periods, sleeping areas for short periods	Use high efficiency space heaters for living zones and electric 'spot' heaters for sleeping areas, or a zoned central heating system
Living and sleeping areas for long periods but at different times of the day	Use a zoned central heating system
Living and sleeping areas both for long periods at the same time	Use a zoned central heating system
Bathrooms/ensuites	Use radiant heaters, e.g. strip heaters or infra-red lamps

Ducted air heating

> Uses convection heaters that circulate warm air around the home through insulated ducts entering rooms through the floor or ceiling.
> Typically run on gas, but electric reverse-cycle air conditioners are also available.
> Are able to heat areas quickly to a thermostat setting.
> Typically up to one third of the total number of outlets can be closed off at any one time, depending on the size of the system. Newer, advanced models allow even greater zoning flexibility.
> Can circulate dust and tend to dry the air
> Systems available are able to serve from 90 m^2 to over 350 m^2 of floor area.

Checklist for greatest efficiency

Should have:

> high star rating (4-5 stars on the Energy Rating label – gas units only)
> well-insulated ducts
> zoning option
> 'positive close-off' floor registers
> electronic ignition
> thermostat with programmable timer.

Hydronic heating

> Water is heated in a boiler and then circulated around the home to radiator panels, skirting board convectors or fan coil convectors that heat the room by convection and radiation.
> Typically fuelled by natural gas, LPG or wood, but also possible to use off-peak electricity.
> Each panel usually has its own control valve to give individual room control.
> Has silent operation, little dust circulation and does not dry the air.

Checklist for greatest efficiency

Should have:

> low water content boiler
> quick response panels, e.g. mild steel with low water content
> well-insulated pipes
> independent valve controls/thermostats in each room.

Space heaters

Space heaters are designed to heat a zone, rather than a whole home (although some wood heaters can produce enough heat for a whole home).

Installing individual space heaters in different zones of a home according to your needs gives you greater heating flexibility.

Gas space heaters

> Produce convective heat, radiant heat, or a combination of the two.
> Run on natural gas or LPG.
> Can be mounted on internal walls where a vertical flue can be fitted, or external walls.
> Some wall furnaces have a rear register to heat an adjoining room.
> Rated for energy efficiency with an Energy Rating label; the more stars, the more energy efficient the unit.
> Units are available to heat from 30 m^2 up to 120 m^2.

Checklist for greatest efficiency

Should have:

> high star rating (5-6 stars on the Energy Rating label)
> heat outlet at floor level
> electronic ignition
> remote thermostat
> power flue
> programmable timer.

Reverse-cycle air conditioners

> Are electric convection heaters that extract heat from the outside air and deliver it into the home, using a compressor and fan.
> Also provide refrigerative cooling in summer.
> Can be installed in a wall or window, as a split system with the compressor outside and console unit mounted internally, or as a central ducted system, usually zoned.
> Are also available in 'multi-split' systems, which utilise more than one internal unit, allowing several rooms to be heated by the one external unit.
> Are available in sizes suitable for bedrooms, living areas or a whole house.
> Heat output of some units declines when outside temperatures drop below 5°C. Look for models which guarantee performance in colder conditions.
> Carry an Energy Rating label – the more stars, the more energy efficient the unit is.
> Inverter technology is available with many brands of reverse-cycle split air conditioners. This allows the compressor to operate at variable speeds depending on the output required, and can potentially reduce running costs, particularly over longer operating periods.
> Suitable for one or more rooms up to 60 m^2. For larger areas, three-phase powered units will be required.

Checklist for greatest efficiency

Should have:

> high star rating (4-6 stars)
> remote thermostat
> adjustable directional louvres
> programmable timer.

Electric space heaters/ panel convectors

> Convection or radiant heaters that use 'peak rate' electricity.
> Can be very expensive to run, so should be limited to heating for short bursts only, e.g. for bedrooms or bathrooms. Not suitable for main living areas.
> Available in sizes to heat up to 70 m^2 of floor area.

Checklist for greatest efficiency

Should have:

> remote thermostat or AA rated unit
> programmable timer.

Solid fuel heaters

> Convection or radiant heaters burning wood, briquettes, coal, etc.
> Highest efficiency units are airtight 'slow combustion' heaters, boilers (for hydronic heating) and furnaces (for ducted heating).
> Require a flue.
> Heating outputs adequate to heat up to around 150 m^2, but require suitable heat distribution methods to disperse heat evenly.
> Are more effective when used in conjunction with thermal mass (e.g. masonry backing wall), or when placed away from external walls to minimise heat escape to the outside.
> Efficiency and performance depend on the quality of wood and method of operation.

Checklist for greatest efficiency

Should have:

> air intake controls, baffles and secondary combustion chambers
> built-in fan to circulate warm air throughout the room
> quality wood supply
> correct method of operation.

Comparative running costs for heaters

In general terms, space heating is more economical to run than central heating, essentially because of the smaller area being heated.

Space heaters

The most economical space heaters are:

> high efficiency (5–6 stars) natural gas heaters
> off-peak electric storage fan heaters
> high efficiency (4–6 stars) reverse-cycle air conditioners.

Central heaters

The most economical central heaters are:

> zoned, high efficiency (4-5 stars), natural gas ducted heaters
> zoned, natural gas hydronic systems
> zoned, off-peak electric in-slab heating.

The actual running costs of a system will depend on a range of variables. These include the size of your heater, operating temperature, hours of operation and the energy efficiency and size of your home.

Other considerations

Thermostat

Installing a thermostat timer can be a cost-effective investment. Typically you can 'set and forget' a weekday program and weekend program, plus use an overdrive switch when you need it.

Portable heaters

Portable heaters are generally small units designed to heat small areas. They are most suitable for short periods of heating such as in bedrooms, bathrooms or infrequently used rooms.

Heating systems and the environment

With the exception of solar energy, every fuel that is used to provide heat gives off gases which contribute to the greenhouse effect. Carbon Dioxide (CO_2) is by far the main greenhouse gas, but others such as methane, nitrous oxide and chlorofluorocarbons (CFCs) also contribute.

Bushfire safety considerations

Heating systems that create gaps and penetrations through open under-floors, walls or roofs are a bushfire concern.

In medium to extreme bushfire areas, the AS 3959-2009 has specific requirements that must be addressed.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

Building Commission
Bushfire Building Advice Line

www.buildingcommission.vic.gov.au

Phone 1300 360 320

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.02 July 2009

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Victoria The Place To Be

> choosing a cooling system

Included in this fact sheet:

> **Assessing your cooling needs**
> **Types of cooling**
> **Finding the best solution for you**
> **Costs and CO_2 emissions**

This fact sheet presents background information relating to types of air conditioning systems, energy usage and efficiency, and other factors to consider when choosing a cooling system for your home.

Before you buy

Summer comfort in your home does not have to be expensive. Stop the heat getting in, and you can avoid purchasing unnecessary cooling equipment with high operating costs.

By paying close attention to the aspects described below, you can reduce heat entering your home by up to 90%.

> Insulating your ceiling, walls and floors where possible.
> Draught sealing around windows, doors and any other gaps.
> External shading to north, east and west windows.
> Ventilation to allow cool outside air into the house.
> Landscaping.

In much of Victoira, there are still relatively few days where the temperature exceeds an uncomfortable 30°C or remains above 20°C at night, so think carefully deciding that you need an air conditioning unit.

Being comfortable

The most appropriate type of cooling system for your home depends not only on local climatic conditions such as air temperature, humidity and air movement, but also on factors such as the time of day cooling is desired, the type of activities you undertake, the clothing you wear and the appliances you use. What is comfortable for one person may not be comfortable for another.

In general, most people find that comfortable indoor temperatures during summer range from 24°C to 27°C with less than 60% relative humidity. If the humidity level is lower or a breeze exists, such as from a fan, we can be just as comfortable even at higher temperatures.

Remember, you do not have to use a lot of energy to cool the house and be comfortable.

Questions to ask yourself

Thinking about these questions will help you determine your cooling requirements.

> Do I need to cool the whole home or just one room?
> How big an area do I need to cool?
> Do I need to lower the inside temperature or will creating a cool breeze be sufficient?
> Is cooling required for short periods or all day?
> Will the running costs affect my choice?
> Is the purchase price my biggest consideration?
> Do I want a portable or fixed unit?
> Will noise from the unit bother my neighbours or me?

Types of cooling systems

The following summary will help you select which system or combination of systems is right for your home. All the systems listed can provide cooling for single rooms or the whole house. More details on each are given in the following pages.

Fans

Fans produce a cooling effect by moving air. The air is either directed around a room or at a person. Fans are an attractive option for summer cooling as they are inexpensive to purchase and operate, yet will often provide an adequate level of comfort. Generally, the higher the air movement, the cooler you will feel. Fans do not reduce actual room temperatures or humidity levels.

> Lowest energy use.
> Lowest running costs.
> Lowest purchase cost.
> Move air, don't reduce temperatures.
> Portable or fixed.
> Quiet operation.
> Lowest greenhouse gas emissions.

Sizing (ceiling fans)

Room area (m^2)	Fan width (sweep)
Up to 10	900 mm (36 inches)
10–20	1200 mm (48 inches)
15–30	1400 mm (56 inches)
30+	two or more fans

Note: if more than one fan is required, the spacing between fans should be approximately three times the fan width.

Considerations

> Ceiling fans should be installed with a clearance of at least 2,100 mm above floor level.
> Mount ceiling fans higher than existing light fittings to avoid flickering shadows, or install a unit with light attached.
> Ceiling fans should be reversible to assist with heating in winter.

Evaporative coolers

Evaporative coolers cool and filter the air. Hot outside air is drawn through a water-moistened filter and then blown through the house. To work effectively, windows and/or doors must be left open so this moist air can exit from the house.

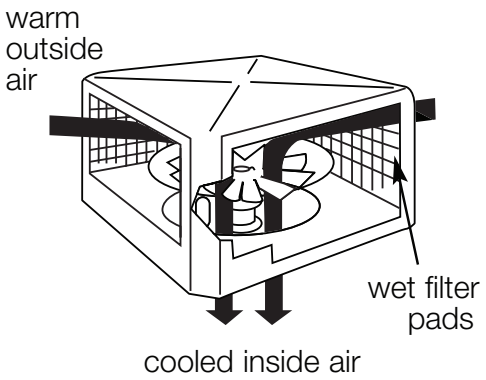


Figure 1: How evaporative coolers work

The area of open windows and doors should be approximately 1m^2 for each cubic metre of air flow per second from the unit. For example, a unit rated at 1.5 cubic metres per second would require open windows or doors totalling roughly 1.5 m^2 in area. If flywire screens are fitted, this area may need to be doubled.

> Low energy use.
> Low running costs.
> Moderate purchase cost.
> Cool the air, but increase humidity.
> Portable or fixed.

> Require water.
> Must have windows or doors open.
> Lower greenhouse gas emissions than refrigerated air conditioners.

Considerations

> Roof-mounted systems will need protective non-combustible mesh in lower bushfire zones and may be prohibited in higher risk zones.
> Evaporative coolers are generally more suitable for areas where humidity is low. If the outside air is already humid then the cooling effect of the unit is limited.
> Open windows and doors on the side of the house opposite the hot prevailing winds to avoid heat entering the house.
> On high humidity days, the highest fan speed should be used. If it is a very humid day, turn off the water supply to the cooler and run the fan only.
> Water consumption for an evaporative cooler depends on the natural humidity of the day. A portable unit might use four litres per hour while a central system could use as much as 25 litres per hour.
> Consider supplementing water used in your evaporative cooler with rainwater.
> Evaporative coolers do not work on a thermostat. They run for as long as you leave them on.
> During winter, ducted units on the roof should have covers placed over them and ceiling vents closed to stop excessive heat loss. Alternatively, consider purchasing a unit with a motorised self-closing winter seal.
> Some central evaporative coolers can be purchased with 'off' timers. These can save energy and provide greater convenience as the unit can be switched off automatically when cooling is not desired (e.g. in the early hours of the morning).

Refrigerated air conditioners

Refrigerated air conditioners remove heat from the air inside the home and transfer it outside.

For every unit of electricity they use, they can provide from 1.5 to 3+ units of cooling, making them very efficient.

> Highest energy use.
> Highest running costs.
> Highest purchase cost.
> Cool, dehumidify and recirculate room air.
> Reverse-cycle models also provide heating.
> Closed system – windows and doors must be kept shut.
> Highest greenhouse gas emissions.

Sizing

The correct sizing of an air conditioner is vital for efficient operation. Never use an air conditioner that is too big for a space, as this will result in short cooling cycles (switching on and off), with little reduction in humidity. Also, frequent on/off cycling is not efficient and adds to the wear and tear on the unit. An undersized air conditioner will not provide adequate cooling.

Air conditioners should be sized based on their **output power** or cooling capacity (not to be confused with the electrical input).

Remember to have a full cooling load calculation carried out by an authorised air conditioning installer or manufacturer before purchasing any system.

Considerations

> Roof-mounted systems will need protective non-combustible mesh in lower bushfire zones or be prohibited in higher risk zones.
> Refrigerated air conditioners are effective in any climate. They are particularly useful in humid areas because they dehumidify the room air.
> Rooms the air conditioner is being used to cool should be closed off so that the room air is recirculated. For example, windows and doors should remain shut.
> If possible, locate window/wall units on the south side of the house. If the unit is exposed to full sun during the day, shade it with an awning or canopy of shade trees. However, do not restrict air flow over it.
> Set thermostats at 26–27°C for summer cooling. Each degree you lower the thermostat can increase running costs by up to 15%.
> Programmable thermostats are also available. These allow you to switch the unit on and off at preset times, potentially saving energy and reducing running costs.
> Look for economy settings
> Multi-speed fans allow you to select high speeds for fast circulation and quick cooling.
> Adjustable and rotating louvres also help to direct air movement more evenly around the room.
> Directional louvres set either horizontally or upwards toward the ceiling assist in cooling.
> Programmable timers allow the system to be switched on or off as required.
> Look for models with an inverter. This technology enables the compressor to operate at variable speeds depending on the output required and can potentially reduce running costs, particularly over longer operating periods. Inverter air conditioners also tend to have faster heat up times and maintain more comfortable internal temperatures.
> Look for the energy star rating when purchasing an air conditioner. The more stars shown on the label, the more efficient the unit. The label also gives an estimate of the annual electricity consumption. Check the Energy Rating label on air conditioners or visit the Energy Rating website (www.energyrating.gov.au) for a detailed, up-to-date list of appliances. High-efficiency units may cost more but can easily pay for themselves over a few years through lower running costs.

Reverse-cycle air conditioners (or heat pumps)

A reverse-cycle air conditioner provides efficient heating and cooling. As they are only marginally more expensive to purchase than cooling only units, they should be considered when looking for an air conditioner.

This mode is not as cost effective for homes in alpine regions that mainly require heating.

Note: performance testing is at 7°C – where most reverse cycle air conditioning perform – but below that temperature, efficiency drops significantly.

Resistance heating

Some air conditioners also provide heating through an electric resistance element. This is a more expensive heating option than using a reverse-cycle unit and you should think carefully before choosing this heating option.

Geoexchange Heat Pumps

Geoexchange (or geothermal) heat pumps use the heating and cooling capacity of the earth to provide air conditioning for a home. These systems remove heat from the air inside the home and transfer it to the ground or ground water. In winter, the process is reversed to provide heating. They are extremely efficient but more expensive to purchase than conventional ducted air conditioning systems.

Noise

Outside the home

An air conditioner can be a noisy and annoying appliance, particularly if you are installing the system close to neighbours. Most air conditioners sold in Australia now have a Noise (dB) Rating label on them. The best approach is to buy the quietest unit for your needs and have it installed as far away as possible from your neighbours, or in a well-shielded or low-use area.

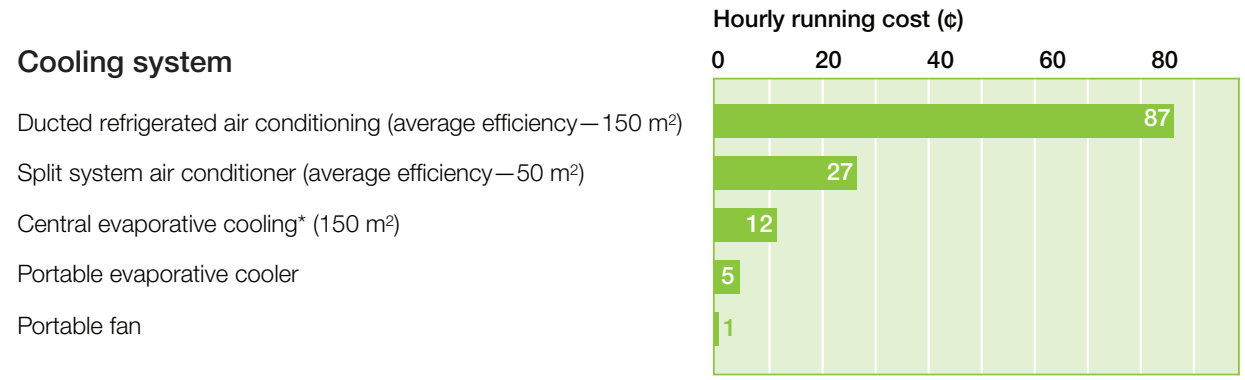
Inside the home

Evaporative coolers tend to give a higher inside noise than refrigerated air conditioners, especially at high fan speeds. Refrigerated room units are noisier than split systems. Ducted or split systems tend to be the quietest due to the remoteness of the operating components.

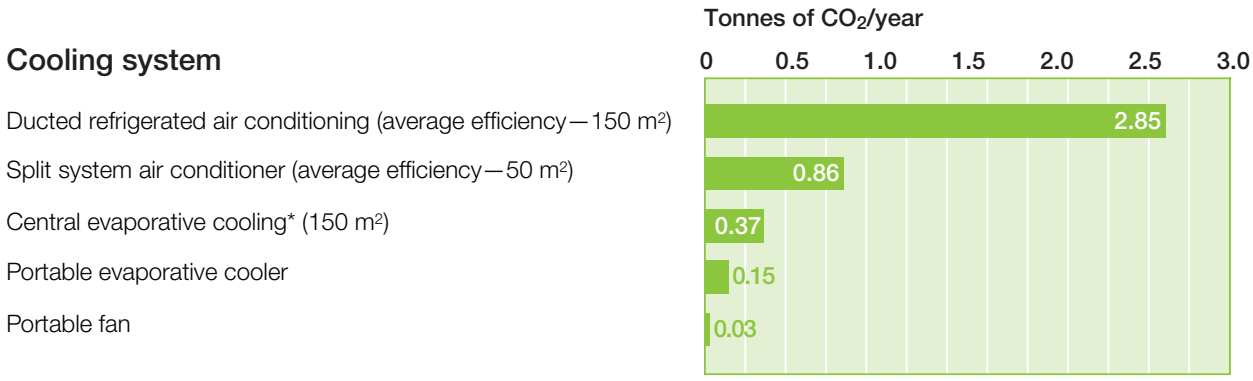
Running costs and CO_2 emissions

The charts below and overleaf provide comparisons of relative average hourly running costs and greenhouse gas emissions for various cooling systems. The energy used to operate cooling systems produces gases that contribute to the enhanced greenhouse effect. Carbon dioxide (CO_2) is by far the main greenhouse gas, but others such as methane, nitrous oxide and chlorofluorocarbons (CFCs) are also produced.

Note: The cost comparisons chart is based on an electricity tariff of 15cents per kWh and the greenhouse gas comparison chart is based on 4 hours average running time per day during the summer period.



*Evaporative coolers may need to operate for longer periods to achieve a cooling effect comparable to refrigerated systems. Water consumption costs are not included.



*Evaporative coolers may need to operate for longer periods to achieve a cooling effect comparable to refrigerated systems. Water consumption costs are not included.

Bushfire safety considerations

Cooling systems that create gaps and penetrations through open under-floors, walls or roofs are a bushfire concern.

In medium to extreme bushfire areas, the AS 3959-2009 has specific requirements that must be addressed.

Further information

For more information on efficiency and air conditioner sizing, see:

www.energyrating.gov.au

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

Building Commission
Bushfire Building Advice Line
www.buildingcommission.vic.gov.au
Phone 1300 360 320

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.03 July 2009

Sustainability victoria

Victoria The Place To Be

> gas water heaters

Included in this fact sheet:

> Benefits of gas water heaters
> Types of gas water heaters
> Choosing the right system
> Energy use and labelling
> Bushfire safety matters

This fact sheet provides an overview of gas water heaters, their advantages and tips for choosing the right one for your home.

What are the advantages of a natural gas water heater?

Natural gas water heaters are one of the most economical types of water heater when operated on natural gas, and produce fewer greenhouse emissions than electrical heaters. Only a gas-boosted solar system is more economical and environmentally friendly.

Tips for choosing the best heater

Size

Choose a heater that is the right size for your household.

Type

> A continuous flow heater, with electronic ignition, is best for smaller households.
> Consider getting a gas-boasted solar water heater or a gas water heater that has connections for adding solar panels later.

Features

When choosing a natural gas water heater the most important energy saving feature to look for is an energy rating of at least 5 stars.

What do the Energy Rating labels mean?

Most gas water heaters carry an Energy Rating label that allows you to compare the annual energy consumption performance of different models.

The annual energy consumption is calculated based on performing the task of delivering the equivalent of 200 litres per day raised 45°C above the cold water inlet temperature. This is the typical hot water usage of a 4-person household.

The star rating and red band shading seen on the label represent the energy saving of the water heater compared with the standard reference water heater (which uses 28,900 MJ per year to perform the above task).

To get 1 star, an appliance needs to pass the Australian Gas Association's minimum performance level. Each additional star represents an additional 7% energy saving.

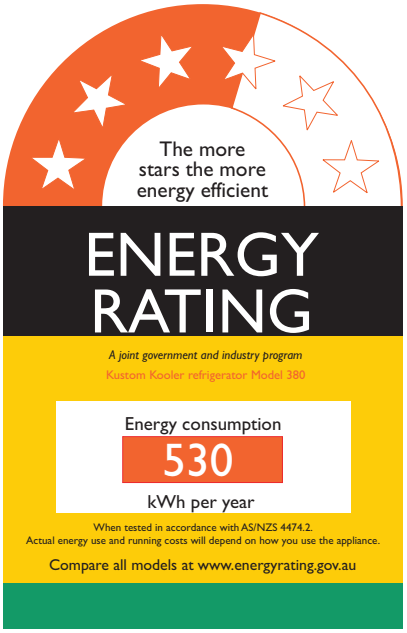


Figure 1: Example of Energy Rating label

Find out more at resourcesmart.vic.gov.au

FAQs

Q. What factors influence the amount of energy used and the running costs of gas water heaters?

A. The energy used and running costs for a gas water heater depend on many influences such as:

> the location of the house
> location of the water heater relative to hot water outlets
> external temperatures
> operating times
> cold water inlet temperatures
> how much water is used
> the quality of installation
> thermostat settings
> user behaviour
> gas tariffs.

Q. Which is the most economical hot water system to buy – gas or electric?

A: Running costs for hot water systems vary considerably depending on the fuel used, so making the right choice when selecting a system is very important.

Solar hot water systems provide the cheapest running costs, produce the least greenhouse pollution, and are increasingly affordable with the Government rebates available.

Natural gas fuelled units are slightly cheaper to run than off-peak electric units; both have a similar purchase costs. Units operating on peak rate electricity and LPG are the most expensive to run. If considering an off-peak electric unit, keep in mind that off-peak electricity prices are increasing faster than peak or 'day-rate' prices and are unlikely to improve in the current electricity market.

Q: Is a gas continuous flow hot water system better than a storage system?

A: Continuous flow units, sometimes referred to as instantaneous gas heaters, are generally slightly cheaper to run than typical storage units. Running costs can be compared by looking at the energy star rating of the unit – the more stars the more efficient the unit and the lower the running costs. Two different types of units with a similar energy rating will have similar running costs.

Continuous flow systems are generally more expensive to purchase and install than storage systems. Both types can be used in conjunction with solar hot water panels, resulting in lower running costs.

Q: How much does it cost to run a 4-minute shower?

A: The running cost can be calculated by considering the following:

> 1 litre of hot water obtained from either a natural gas hot water service or an off-peak electric hot water service costs about a third of a cent

> the average showerhead uses approximately 20 litres of hot water per minute. Assume half of this is hot water i.e. 10 litres

> multiply one third of a cent by the litres per minute and number of minutes

> i.e. 0.3 X 10 (litres per minute) X 4 (minutes) = 12 cents

> please note that this is an approximate figure. If a solar hot water system is used, the final figure can be multiplied by 0.4 as solar heating is much more cost and energy efficient.

Bushfire safety considerations

All above-ground gas and water supply pipes within bushfire zones must be of metal.

Further information

For more information on efficiency and air conditioner sizing, see:

www.energyrating.gov.au

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

Building Commission
Bushfire Building Advice Line

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Phone 1300 360 320

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.04 July 2009

Sustainability victoria

Victoria The Place To Be

> lighting

Included in this fact sheet:

> **Lighting in your home**
> **Efficient lighting types**
> **Practical issues to consider**
> **Choosing the right light for the job**

This fact sheet provides information on the different types of energy efficient lighting products available, how they work, and practical issues to consider when choosing lighting options for your home.

Why incandescent lights are inefficient

Incandescent lights ('standard' globes) operate by heating a small wire filament so it becomes white hot and emits light. However, much of the energy goes into producing unwanted heat as well, so these lights are actually very inefficient.

Incandescent lights are also relatively short lived – only lasting around 1000 hours – which adds to their overall cost. You can choose from many better money-saving alternatives today. Incandescent lights are being withdrawn from the market.

Types of energy efficient lighting

There are a number of different lighting technologies available in Australia today that are more energy and cost efficient than traditional incandescent lights. Choosing energy efficient lights can help you reduce your energy consumption for lighting by up to 80%.

The key types of lights include:

> compact fluorescent lights (CFLs)
> fluorescent tube lights
> light Emitting Diodes (LEDs).

Compact fluorescent lamps (CFLs)

Compact fluorescent lamps were relatively expensive when first introduced in the 1980s, but in recent years their cost has reduced significantly and they now provide a very cost effective form of low energy lighting.

Although there is a 'warm up' delay in the lights – so they can take a minute or two for the full light to become active – CFLs offer a number of important advantages, including:

> compact size
> use up to 80% less energy than an incandescent globe
> can be installed in the majority of light fittings that take traditional, incandescent globes, without any change to the light fitting
> available in a range of new colour styles, including warm white or cool white. This makes CFLs more suitable for a wider range of situations
> long life (6 to 15 times longer than traditional incandescent globes). So, even though CFLs are more expensive to buy, their longer life and low energy use means they are less expensive to use overall.

Other recent developments in CFLs include:

> new low energy lighting CFLs that can be used like halogen spotlights. These fit in a standard 240V halogen fitting but use about 80% less energy
> dimmable globes that can dim down to 25% of their output with a conventional dimmer
> floodlight PAR 38 lamps for outdoor use that can reduce energy use by around 85%
> very compact models that can be used in table lamps and small light fittings
> models that can replace the candle effect lights in chandelier-type light fittings
> reflector lamps.

Overall, CFLs are very energy and cost efficient (even taking into account their higher purchase cost). They can be used in wide variety of lights, are long lasting, better for the environment AND will save you money.

Fluorescent tubes

Florescent tubes have been around for many years and are ideal for areas where good quality lighting is required for long periods. They can give off more light than incandescent lamps or CFLs, so they are especially suitable for larger spaces that require good lighting - living rooms, kitchens, laundries, playrooms, hallways, garages or external areas.

Fluorescent lights use about 70%-80% less energy than comparable incandescent lights. As a long-lasting light their replacement costs are also low.

Fluorescent tubes come in a range of styles (straight, square and circular) and offer different types of light, ranging from bright white to a more natural, warmer light. Light fittings for fluorescent tubes also vary – either covering the globe or leaving it visible – and different styles are available to suit all rooms and requirements.

The main disadvantages of fluorescent lights include their higher initial purchase cost, the need for a fluorescent light fitting to be installed, and the fact that some people regard their light as too harsh and white. Warm white tubes give a far more natural light than ‘daylight’ or ‘cool white’. They are very energy and cost efficient, can provide lots of light, and last a long time.

Light emitting diodes (LEDs)

LED lights have been around since the 1960’s, but the technology has only evolved recently to the stage that LEDs can be used for household lighting. LED lights are more energy efficient than incandescent and halogen lights and will become increasingly so as the technology develops.

LED lights are already an energy efficient alternative to 12V halogen lights or some 240V incandescent spotlights, and are widely used for garden, pathway and pool lighting. Their light output is still considered too low for general room lighting, however the technology is advancing quickly.

LEDs are relatively expensive, but they are becoming cheaper and they have a very long life. This makes them especially useful wherever replacing light globes is difficult or expensive – hence their use in pool lighting.

Halogen lamps

Halogen lamps are similar in design to incandescent globes, but are filled with a halogen gas and designed to operate at much higher temperatures, creating a brighter light more efficiently. They generally last twice as long as incandescent lights.

Halogen lights are most often used as downlights and in-track lighting. However, they do not work well as a form of general lighting as it can take four to six downlights to light the same area as one standard light.

Also, safety standards recommend that a large gap be left in any insulation installed above your halogen lights. This significantly decreases the effectiveness of your insulation. Overall, using halogens for general lighting is not recommended, as it will add to your lighting and energy costs.

Comparing lifetime running costs

When choosing what type of lighting to install there are two costs to be considered:

> globe replacement costs
> energy costs.

Replacement cost and frequency

Globe replacement costs vary considerably as does their lifespan (how often you need to replace them). This can have a significant impact on your ongoing running costs.

For example, incandescent globes may cost less than $1, but their operating life may only be 1,000 hours, about one year of average use. In comparison, a CFL may cost $3 to $7 to buy, but its life might be 10,000 hours, giving you approximately ten years of use.

Over 10,000 hours of use an incandescent globe may have to be replaced 10 times, at a cost of around $7.50, while a CFL would be replaced once for around $5.00.

Energy costs

The energy costs of different light types can vary by three or more times.

If a light is used for 5 hours a day on average, this equates to around 1,800 hours of use annually. For an incandescent 100W light, annual energy costs will be around $30. A CFL giving a similar light output will only cost about $7 to operate, which is a $16 saving.

The lifetime costs for several common lights are calculated in the table below and show that CFL lights are much less expensive to buy and operate in the long term.

Light fittings and energy efficiency

Your choice of light fitting, as well as the technology behind it, will have an impact on your home's energy efficiency.

Pendant light fittings

Pendant fittings hang from the ceiling and provide the maximum lighting from a single globe. They are the most energy efficient light fitting for general illumination.

Where possible, choose fittings that are compatible with CFL globes to gain the greatest energy advantage.

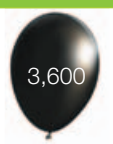
	Power	Approximate balloons of greenhouse gas	Purchase price	Expected operating hours	Electricity running costs per year (approximate)
Incandescent 	75 Watt		$1.00–$1.20	1,000–2,000 Hours	$12.30
Flourescent 	15 Watt (75 watt equivalent)		$4.00–$10.00 (cheaper if buying a packof 2 or 3 lights)	Around 8,000 Hours	$2.30

Figure 1: Example of running costs for incandescent and compact fluorescent light bulbs

Downlights

Downlights are very popular, especially low-voltage halogen downlights, which are great for feature lighting and specific task lighting, such as in a kitchen. However, low voltage does not mean low energy. As well, downlights are not efficient for general lighting – requiring many more globes to achieve the same effect – and so can add significantly to your lighting and energy costs.

If you do decide to install spotlights, choose fittings that can use reflector mini-CFL globes or LED lights to maximise your energy savings.

You should also avoid installing downlights that are recessed into the ceiling if possible. These cause gaps in the ceiling insulation, particularly if the lights require the insulation to be set back from the lights to allow heat to dissipate. The resulting gaps can greatly reduce your insulation's impact, making your home much harder to heat or cool and significantly increasing your energy costs.

Track lighting

Track lighting, or spotlights that can be attached to your ceiling or walls, are much more practical than recessed downlights. They are easier to install, don't require leaving gaps in your home's insulation and can be adjusted to point at different places in a room.

Multiple globe light fittings

Some light fittings contain a number of smaller light globes instead of a larger globe. This is usually significantly less efficient than using a single larger globes and leads to a higher cost for replacement globes. If you do opt for such a multiple fitting use the mini CFL lamps rather than less efficient incandescent light globes.

Other useful lighting products

Sensor lights

Sensor lights can help reduce your energy costs as they are switched on by motion sensors and can be a good alternative to leaving lights on for long periods.

Lights incorporating sensors are available or sensors can be bought separately.

To avoid sensors switching lights on inappropriately, check if they can be adjusted or choose a motion/daylight sensor combination that prevents the light from operating during daylight.

Sensor operated night lights are also available for use in rooms such as bathrooms and hallways. These can be a low-energy alternative to leaving your hall or bathroom lights on for children or guests.

Lighting timers

Lighting timers, which switch lights on and off at programmable times, are another lighting option worth considering for external or security lights as they can reduce the length of time the lights are in operation. These times can be permanently installed or other timers can be connected to 'plug-in' lights.

Solar lights

Solar powered lights are now inexpensive and readily available from hardware stores. As well as being decorative and cost-effective, they can provide an efficient and convenient alternative to some forms of traditional lighting. Solar lights usually only offer low levels of illumination, but this can be enough to light your garden, a small shed or an outside area.

FAQs

Q. Do fluorescent globes really save money?

A. Yes. As an example, a 25-watt CFL will provide the same amount of light as a 100-watt incandescent. This means the fluorescent globe will cost approximately one quarter of the cost of the incandescent to run, so there is a significant saving. So, even though fluorescent globes cost more to purchase, they will save you money in the end.

Q. Are halogen/low voltage lamps (e.g. downlights) energy efficient?

A. Generally, no. Although halogen lamps are around twice as energy efficient as incandescent lamps (a 50w halogen light will provide around the same light output as a 100w incandescent globe), they also require the use of a transformer that can consume up to 15w of energy making them less energy efficient. As well, because halogens only have a narrow beam, they are unsuitable for general or ambient lighting. If you want to illuminate a room it will take many more halogen lights to achieve the same effect as a single incandescent globe so running costs will be significantly higher. Instead, consider using halogen lights for spot or 'task' lighting, such as over a kitchen bench.

Q. Is it true that fluorescent lights use large amounts of energy to switch on, making them expensive to run?

A. No. Although fluorescent lamps use more energy on start-up this is only for a fraction of a second, so there is really no effect on running costs.

Q. Is it true that fluorescent lamps should not be switched on and off all the time? For energy efficiency, how long should you wait?

A. Yes, frequent switching of fluorescent lamps does reduce their lifespan. This is one reason why it is recommended that fluorescent lights be installed in rooms where the light is left on for longer periods (e.g. living areas). To maximise the lifespan of your light and minimise its running costs, it is recommended that you switch the light off if you leave a room for more than five minutes.

Q. Do light dimmers save money?

A. Yes, but the saving is not proportional. By dimming a light to half its light output, you save around one quarter of the running costs.

Further information

For more information on efficiency and air conditioner sizing, see:

www.energyrating.gov.au

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.05 July 2009

Sustainability victoria

Victoria The Place To Be

> dishwashers, fridges and freezers

Included in this fact sheet:

> Choosing the right appliance
> Energy and water use
> Labelling of appliances
> Looking for the best features

This fact sheet presents useful information about choosing a new dishwasher, fridge and/or freezer. Included are facts about energy and water usage, labelling conventions, plus handy features to consider when making your purchase.

Dishwashers

About 50% of households in Victoria own a dishwasher. Most people use their dishwashers between 4 and 7 times per week (up to 365 times per year) although this varies by household. The average lifespan of a dishwasher is 11 years.

When choosing a new dishwasher, make sure to consider energy and water usage. Most of the energy used in a dishwasher is for water heating, so energy efficient models can save you both energy and water over the lifetime of the machine.

Issues to consider when choosing a dishwasher

Size – make sure the dishwasher's load capacity will suit your general needs (and that your plates and glasses will fit into the racks).

Type – your type of hot water system will have a significant influence on what type of dishwasher will be most energy efficient. The recommendations include:

> If you have a gas or solar hot water system, then a dual water connection model is recommended. These can be connected to both hot and cold water and will reduce both carbon dioxide (CO_2) emissions and operating costs.
> If you have an electric hot water system, then a cold water connection is best, as the dishwasher will heat its own water only for the parts of the cycle where hot water is needed. This will be energy efficient.
> A dishwasher connected to hot water only will use the most energy, although it may be marginally economical if you have either off-peak electric, solar or mains gas hot water.

Energy saving features to look for

> An energy rating of at least 3.5 stars.
> A water rating of at least 3.5 stars.
> A filter that is easy to remove and clean.
> Special features such as economy programs, which use less energy than the 'normal' program.
> Half load washing option.
> Delay-start function to take advantage of cheap 'off-peak' electricity or 'time-of-use' tariffs.

FAQs

Q. Are dishwashers tested on real dirty dishes and cutlery?

A. Yes. The Australian Standard requires the test to include a range of standard dirty products in the test wash. After the wash, contents from all parts of the dishwasher are carefully inspected to see if they pass the wash quality test.

Q. What are the two energy consumption figures shown on the dishwasher label?

A. The Energy Rating Label for dishwashers shows the energy consumption for two water connection options. Some dishwashers are made for connection to cold water only, and heat the water internally as required. Other models can be connected to either hot water or to both hot and cold. The energy consumption for the manufacturer's recommended connection is displayed in the red box and energy consumption for the alternative hot water connection is written on the label below.

Q. Which water connection uses the least energy when running a dishwasher?

A. For single water connection models, a dishwasher that is only connected to the cold water supply is generally the most energy efficient to run. The dishwasher heats the water for the wash cycle and cold water is used for the rinsing and prewash cycles.

Q. How do dual hot and cold water connections save energy?

A. Dishwashers with dual hot and cold water connections will use hot water only for those cycles where it is required. These dishwashers have shorter operating times and, if connected to a mains gas or solar water heater, have both lower running costs and lower greenhouse gas emissions.

Q. What is the most efficient dishwasher to buy?

A. A list of energy and water rated dishwashers is available at

> www.energyrating.gov.au

> www.waterrating.gov.au

How are the Energy Rating labels decided?

An approved Energy Rating label must be displayed on all dishwashers that are offered for sale in Australia. To determine the energy consumption and performance and to set requirements for energy labelling, dishwashers are tested against the Australian Standard AS/NZS2007.

To be eligible for an Energy Rating label, a dishwasher must be able to meet the specified washing and drying performance criteria defined in the Australian Standard. The product must also demonstrate that it is capable of washing the specified load (e.g. a number of place settings) and that the water consumption and water pressure data provided by the manufacturer is accurate.

The '1' star line is defined by what is called the base energy consumption. For dishwashers, a product is awarded an extra star each time the figure in the coloured box is reduced by 30% from the base energy consumption.

Refrigerators & freezers

A refrigerator is the single biggest power consumer in many households, after electric hot water heaters. Nearly all households have at least one refrigerator and about 30% own two. The average lifespan of a fridge is 13 years. Nearly 60% of households own a separate freezer.

Although energy efficiency should be a critical factor in deciding which fridge or freezer to buy, approximately 45% of purchases are made on impulse with no prior research. This is mainly due to the urgent need for a new fridge when the previous one breaks down.

Issues to consider when choosing a fridge or freezer

Size – think about what size of fridge you really need. If the fridge will not be at least two thirds full, or a freezer at least three quarters full, it is too big for your needs.

Type – there is a variety of fridges and freezers available on the market today, each of which has its advantages and disadvantages. The following issues should be considered before deciding which type to purchase:

> frost-free fridges are generally less efficient than cyclic defrost models due to:
  - the energy use of the fan
  - the need to maintain a very low temperature in the freezer (to cool the fresh food compartment as well)
  - the energy needed to defrost both the freezer and fresh food compartment.

  That said, some well-designed frost-free fridges have lower energy use than some cyclic defrost models.

> vertical/upright freezers have a front-opening door. Contents can be checked, packed and unloaded relatively quickly and this minimises the time that the door is open.

> chest freezers have a top opening lid and are generally more economical to run as they hold cold air more efficiently.

> it is usually less costly to run one large refrigerator than two smaller ones, but check the energy consumption on the label when assessing your options.

> if two different sized refrigerators use the same amount of energy, the larger model can be considered more efficient because it keeps more space cold with same amount of electricity.

Energy saving features to look for

> An energy rating of at least 4 stars, a chest freezer with at least 3 stars, and an upright freezer with at least 4.5 stars.
> Adjustable shelving – you will be able to store products of different shapes and sizes, and they will be more accessible for cleaning and defrosting.
> Easy access to the thermostat.
> Easily read thermostat controls.
> Door open alarm.
> Dimensions that allow adequate space (5-cm gap) around the unit for ventilation.
> Rollers or castors will make it easier to move to clean the coils at the rear of the unit.
> Models with inverter technology will be more efficient, as they can adjust their compressor output to match vary cooling demands.
> Single door fridge/freezers have manual or push-button defrost and, if defrosted regularly, are very energy efficient to run.
> Manual defrost models have tended to use less energy than frost-free models (automatic defrost), but these must be defrosted periodically to remain energy efficient. However, the best frost-free models on the market are now as good as manual defrost models – check the energy label.
> Automatic ice-makers and through-the-door dispensers both increase energy use (typically 100 to 150 kilowatt hours/year).

FAQs

Q. How can two different fridges have different kWh ratings, yet have the same star rating?

A. Fridges and freezers are divided into different class and size categories. Class categories include Frost Free, Cyclic Defrost, Fridge with Freezer, etc. If two fridges with the same capacity have different kWh ratings but the same star rating, it is likely that they belong to different classes or different sizes.

Q. What effect does the size of the fridge have?

A. In general, the larger the refrigerator, the more energy it uses. Choose the size of fridge that is best suited to your needs.

Q. What factors affect the cost of running a refrigerator?

A. Running costs vary according to:

> The size and efficiency of the unit
> The effectiveness of the refrigerator's insulation
> The outside air temperature (in hot weather, heat will leak into the cabinet more quickly, requiring more energy to maintain low temperatures)
> The presence of adequate ventilation around the refrigerator
> The frequency of door opening.

Q. Which uses less energy – a chest freezer with a top-opening lid or an upright freezer?

A. Upright freezers are usually less efficient to run. Cold air, being heavier than warm air, will flow out of an upright freezer when the door is opened.

Q. What is adaptive defrost?

A. Adaptive defrost is one of a number of new smart technologies for refrigerators where the appliance automatically adjusts how often the fridge is defrosted depending on the frost load on the evaporator. Adaptive defrost systems are recognised by the Australian Standard for refrigerators and freezers, but at this stage a realistic test for these controls is not included in the test method. The Standard assumes that at least one defrost per day will occur during normal operation, although some smart systems may have a longer time between defrosts under normal conditions of use.

Q. What is the most efficient fridge to buy?

A. A list of energy rated fridges is available at www.energyrating.gov.au

What do the Energy Rating labels mean?

Minimum Energy Performance Standards (MEPS), which set minimum efficiency levels for refrigerators and freezers, came into force on 1 October 1999, thus eliminating the worst performers from the market. However, for many types of refrigerators, there is still a large difference in energy consumption between the best and worst models. The best models, in some cases, use half the energy of models that just pass MEPS.

An approved Energy Label must be displayed on all refrigerators and freezers that are offered for sale in Australia. This label can provide you with important information about the effectiveness of the different models. For any given type of fridge or freezer, the model with the most number of stars will be the most energy efficient.

To determine a model's energy consumption and performance, and its appropriate energy label, all refrigerators, freezers and refrigerator-freezers are tested against the Australian Standard AS/NZS4474. To be eligible for an energy label, a refrigerator has to meet a temperature operation test and a pull down test as defined in the Australian Standard.

The '1' star line is defined by what is called the base energy consumption. For refrigerators and freezers, a product is awarded an extra star each time the figure in the coloured box is reduced by a certain percentage. Energy reductions per star vary from 14% to 23% per star, depending on the refrigerator or freezer group.

Further information

For more information on efficiency and air conditioner sizing, see:

www.energyrating.gov.au

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 3.06 July 2009

Sustainability victoria

Victoria The Place To Be

> washing machines and clothes dryers

Included in this fact sheet:

- > **How to choose the best washer or dryer for your needs**
- > **Energy saving features to look for**
- > **How to interpret the labels**

This fact sheet presents useful information on choosing a new washing machine or clothes dryer, energy usage and efficiency, plus handy features to consider when making your purchase.

Washing machines

More than 95% of households in Victoria own a washing machine. On average, these are used five times a week, although this can vary widely between households. Washing machines generally have a lifespan of around 11 years.

When deciding which washing machine to buy, it is wise to consider both energy usage and water efficiency. However, research shows that 45% of washing machine purchases are made on impulse – probably due to the immediate need for a replacement when an old one breaks down.

How do I choose the best washing machine for my needs?

Size - Think about the size of machine you really need. A larger than necessary machine will use more energy and cost more to run, while a machine that is too small will not meet your needs.

Type of clothes washer – There are two main types of clothes washer: drum type machines, usually called front loaders, and top loaders.

Each has its advantages and disadvantages, however front loader machines are generally more energy and water efficient.

Before deciding whether to buy a top loading or a front-loading clothes washer, think about whether you want:

- > a quick washing cycle
- > to minimise wear and tear on your clothes
- > water efficiency.

The answers to these questions may make a difference to your choice of washing machine. Some of the aspects to consider for each type of clothes washer include:

Top loaders

- > Generally faster washing times (30-45 minutes).
- > Generally use more water, which means that on a warm wash they use more energy.
- > Wear and tear on clothes is harsher (especially impeller types).
- > Usually less expensive to purchase (although not always).
- > Generally have a range of cold washing options.

Front Loaders

- > Generally slower washing times (typically 60-90 minutes).
- > Generally use less water, which means that on a warm wash they use less energy.
- > Much more gentle on clothes and usually wash better.
- > Can be more expensive to purchase (although not always).
- > Some have only single cold connect (internal water heating) and some have limited cold water washing options.

Energy saving features to look for

> An energy rating of at least 3.5 stars.
> A water rating of at least 4 stars.
> A model with automatic load sensing and water level adjustment. This will ensure that the minimum amount of water and energy is used for each load. Or at least make sure there is a variable water level so small loads can be washed efficiently.
> A model that can wash in cold water. Although the washing performance is generally reduced when using cold water, you will typically save 80% to 90% of the energy. If you use cold water for washing half of the time, you will save half the energy.
> A cold rinse option for all of the common programs on the washing machine. This will give you the option to save more energy.
> A good spin performance (e.g. high spin speed) as this can cut down on your overall energy use, especially if you dry some or all of your loads in a clothes dryer.
> A machine that has a hot and cold water connection. If you use solar, gas or off peak electric hot water, the total cost of energy will be greatly reduced for those loads you do wash on a warm setting. Internal water heating is generally more expensive, although front loading machines use less water and less energy overall.
> A suds saver option. This saves energy and reduces the washer's water consumption.
> Delay-start function to take advantage of cheaper 'off-peak' electricity.

Washing machine FAQs

Q. Does a clothes washer wash as well on cold water as on hot?

A. Most people find that cold wash cycles using modern detergents are quite satisfactory and save a lot on energy costs. On the Energy Rating label for clothes washers, the cold wash energy consumption is displayed in the blue box and the warm wash energy consumption is displayed in the red box. However, on heavily soiled clothes a warm or hot wash may be necessary.

Q. What type of clothes are the washing machines tested on?

A. Energy consumption is measured on the program recommended for a normally soiled cotton load. After the wash, the soiled samples are removed from the clothes washer and are inspected to see if they pass the wash performance.

Q. Does the 'suds saver' save energy?

A. The 'suds saver' feature on a clothes washer is designed primarily to save water. But if you are doing a hot wash, the suds saver feature will allow you to save hot water, which in turn saves energy.

Q. Does water consumption alter the running cost of a clothes washer?

A. Yes. If using warm wash cycles, the energy for heating water accounts for about 80 to 90% of the total energy consumption. Therefore, models with low water consumption use less energy. To calculate water costs, check with your local water supplier to find out what water and wastewater tariffs apply to your home.

Q. What is the most efficient washing machine to buy?

A. A list of energy and water rated washing machines are available at

> www.energyrating.gov.au
> www.waterrating.gov.au.

What do the labels mean?

There are two kinds of labels for clothes washers. The cold/warm wash label is used on machines where the user can select the temperature setting. The other label is used where this option is not available.

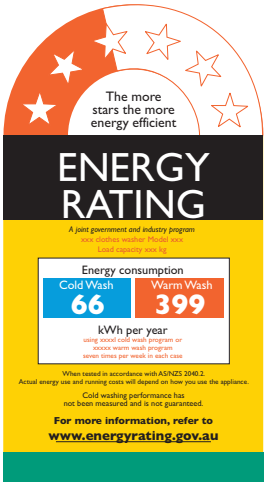


Figure 1: Cold and Warm Wash Labels

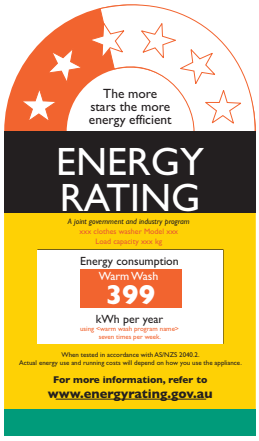


Figure 2: Warm Wash Only

All washing machines for sale in Australia must carry an approved Energy Rating label. To determine the energy consumption and performance (and therefore the right energy label), clothes washers are tested against the Australian Standard AS/NZS2040.

To be eligible for an Energy Rating label, a clothes washer must be able to meet a minimum level of wash performance, a minimum level of spinning performance and must not exceed the 'wear and tear' limits that are defined in the Australian Standard. The product must also demonstrate that the water consumption and water pressure data provided by the manufacturer is accurate.

The standard energy labelling test for clothes washers specifies a warm wash – as a result the majority of the energy consumption shown in the Energy Consumption box on the on the label is for heating the water. So, choosing a model with a low water consumption will help you save energy and water.

The '1' star line reflects the machine's base energy consumption. For clothes washers, a product is awarded an extra star each time the figure in the coloured box is reduced by 27% from the base energy consumption.

Clothes dryers

About 60% of households in Victoria own clothes dryers. Some households use them as little as once per month while others use them to dry every load they wash. Dryers last on average for 11 years.

How do I choose the best clothes dryer for my needs?

Energy efficiency should be an important factor in your choice of which machine to purchase. But while energy efficiency can help minimise your running costs and your impact on the environment, approximately 55% of clothes dryer purchases are made on impulse with no prior research. This is probably due to the relatively cheap price of replacing a dryer should it break down.

If you are a moderate to heavy user of your clothes dryer, it is important to pay particular attention to the star rating when making a choice. You also need to consider the size of machine you need, and which features would be of most to you.

Energy saving features to look for

> An energy rating of at least 2 stars.

> Automatic sensing – auto-sensing dryers automatically detect the dryness of clothes and turn off when clothes are dry enough. This feature prevents over-drying and cuts down on energy usage.

> Easily accessible lint filters.

> Venting kit to expel moist air to the outside of the house (or purchase a 'condensing' model instead).

> Temperature settings that are suitable for the load types that you will dry most often (e.g. towels).

> Special features such as reverse tumbling and cool down options (e.g. denim and anti-crease cycles) to reduce wear and tear on clothes.

> Delay-start function to take advantage of cheap 'off-peak' electricity if you are on a 'time-of-use' tariff.

Clothes dryer FAQs

Q. Do auto-sensing dryers save energy?

A. Yes. Auto-sensing dryers switch off automatically and do not waste energy by continuing to run once the clothes are dry. The energy wasted by a dryer that relies upon a manual timer will depend on how diligent you are in checking the progress of your clothes.

Q. What is the most efficient clothes dryer to buy?

A. A list of energy-rated clothes dryers is available at www.energyrating.gov.au

Energy rating labels

All clothes dryers sold in Australia must display an approved Energy Rating label. To work out their energy consumption and performance, clothes dryers are tested against the Australian Standard AS/NZS2442. Requirements for eligibility include the ability to dry a standard load in a single operation to a specified level of dryness, a maximum clothes temperature limit (to prevent scorching) and minimum efficiency requirements. The initial moisture content of the clothes is also defined in the Standard.

The '1' star line reflects base energy consumption. For clothes dryers, a product is awarded an extra star each time the figure in the coloured box is reduced by 15% from the base energy consumption.

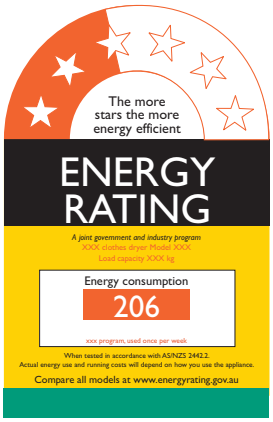


Figure 3: example of an energy rating label

Further information

For more information on efficiency and air conditioner sizing, see:

www.energyrating.gov.au

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

Renewable energy options

Victoria
We will rebuild

Sustainability victoria

Victoria
The Place To Be

> solar photovoltaic (pv) systems

Included in this fact sheet:

> **Understanding solar PV systems**
> **Benefits of solar-generated electricity**
> **Choosing a system that's right for you**
> **Improving your energy efficiency**

The aim of this fact sheet is to provide you with general advice on the purchase and installation of a grid-connected solar photovoltaic (PV) system for your home. Before making a final purchase decision, you should always seek advice from a supplier or qualified PV installer.

What does a solar PV system do?

Solar PV systems (also known as solar electric systems) are designed to:

> use sunlight to generate electricity for your domestic use
> store excess electricity in batteries for later use or to feed into the electricity grid to reduce your electricity bill.

A solar electric system is different to a solar water heater. This guide deals only with solar electricity. Solar water heaters use heat from the sun and/or surrounding air to heat water – they do not produce electricity.

Benefits of a solar PV system

> Solar PV systems generate electricity.
> Once the system has been installed, electricity is generated from a 'free' source, i.e. the sun.
> Solar electricity is generated without emitting greenhouse gases.
> Solar panels or modules are silent, without any moving parts.
> Solar modules are usually mounted on the roof or a house.
> Solar electricity can either supplement or provide all your electrical consumption.
> Solar electricity can be fed into the electricity grid.
> Additional solar modules can be added later to increase capacity as demand or budget grows.
> A solar module should last for 20–30 years.

Stand-alone and grid-connected solar PV systems

There are two basic types of small solar power systems:

1. grid-connected solar power systems
2. stand-alone power systems.

If a mains electrical supply connection is present or available then you should consider a grid-connected solar system. A stand-alone power system costs significantly more than a grid-connected system and should only be considered if the cost of connection to the power grid is more than $30,000.

How does a grid-connected solar PV system work?

A grid-connected solar PV system consists of an array of photovoltaic modules connected via an inverter to provide power for your home with excess production feeding into the grid.

At night, when the solar modules are not producing electricity, the electricity comes to you from the grid. If you export enough energy during the day, it will balance or exceed the amount you draw from the grid at night.

Key components of a grid-connected solar PV system

The key components of a grid-connected solar power system are:

> Solar modules – convert sunlight to DC electricity
> Grid interactive inverter – converts DC electricity to AC electricity
> Import-export utility meter – measures electricity exported to and imported from the grid.

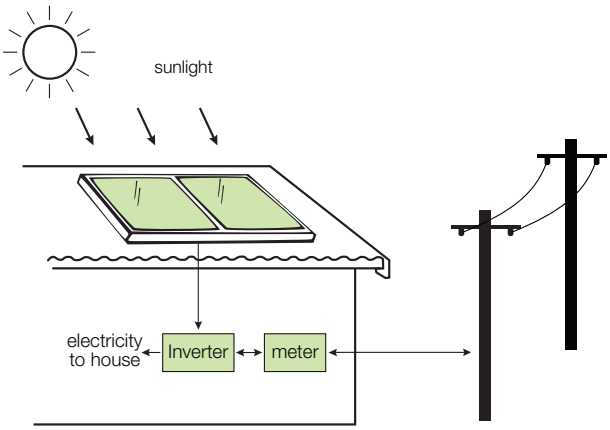


Figure 1: A typical photovoltaic system

Solar modules

Solar modules are made up of solar cells and are usually mounted on roofs or other structures. There are three general classifications of solar cell technologies that vary in efficiency.

One type is not necessarily better than the other, however lower efficiency modules take up a greater roof area than higher efficiency types for the same power output. The table presents general guidelines to help understand the effect of cell efficiency on the size of the array.

Cell Type	Efficiency	Roof Area for 1 kW
Monocrystalline	12% – 18%	8 m^2
Polycrystalline	10% – 13%	10 m^2
Thin film or amorphous	3% – 6%	20 m^2

Figure 2: Cell types and sizes

For all solar modules:

More energy is generated
> in areas of strong solar radiation > on long, sunny days
Less energy is generated
> in cloudy or rainy weather > when the panels are shaded by trees or other obstructions

In Victoria, the average energy produced by a 1 kW solar system is about 1,230 kWh.

Grid interactive inverter

An inverter is an electronic device that converts the direct current (DC) produced by the solar modules into alternating current that is fully compatible with the standards for the Australian power system. Inverters are usually mounted near the household switchboard.

Import export utility meter

Your house will require a meter that can record the import and export of electricity in half hour intervals. There are new electronic meters that are currently being deployed in Victoria.

Your electricity distributor reads the meter for imported and exported electricity and your electricity retailer then bills you for the energy consumed OR provides a credit for any excess exported power.

Figure 3: Modern digital meter.

Figure 4: Old-fashioned meter

Choosing the right system

Factors to consider

> your **electricity demand** – how much you use. The more electricity you demand, the larger the system you will need and the greater the cost.

> **your budget** – how much are you prepared to invest? Your budget may limit the size of the system.

> **aspect** – there needs to be sufficient space on your roof for the mounting of north-facing modules.

Choosing the system size

An energy efficient house may need about 2.5 kW of solar power to meet its average annual electricity needs. While the ideal outcome is to provide enough energy to run all your electrical appliances all year round, the reality is that your electricity usage and your budget may not always coincide.

Often the compromise is to have a solar PV system that will supply only part of your total electricity demand; however, you can always add to it later. The most common systems are rated at about 1.5kW.

You should always consider some energy conservation and energy efficiency measures to reduce your electricity consumption so that a larger portion of your electricity use will come from your solar PV system – e.g. avoid installing electric space heating and electric hot water.

Reducing demand

While the power you generate can help offset electricity charges, it is important that you also consider other cost-effective ways of reducing the energy used around your house.

These alternatives include:

> buying the most **energy efficient appliances**

> **replacing incandescent light globes** with compact fluorescent lamps

> **avoiding installing quartz halogen downlights** as most are very inefficient

> **switching off stand-by loads** such as those consumed by DVDs and computers when not in use

- installing a **solar water heater**, preferably with gas or wood heater boosting – this will cut electrical costs
- utilising **motion sensors**, timers and home automation systems
- positioning **summer shading** or reflective coatings on west facing windows
- **reducing electricity demand** for space-heating and cooling (e.g. by dressing for the climate, judicious setting of thermostats, use of curtains and incorporating energy efficiency features into new buildings, such as lights, insulation, summer shading, etc.)
- ensuring that there is adequate **solar access in winter** to provide passive heating.

Design and installation

It is recommended that you have your solar power system specified, designed and installed by a person with Business Council for Sustainable Energy (BCSE) accreditation. This ensures that they:

- have undergone the necessary **professional training**
- follow **industry best practice**
- must **adhere to Australian Standards**
- routinely **update their skills and product knowledge**.

It is also wise to:

- consider the recommendations of others who have purchased a similar system to the one you require
- engage someone with whom you're happy to work
- engage someone who has experience designing and installing PV systems.

Orientation

Solar modules produce most electricity when they are pointed directly at the sun. It is important to install them so that they receive maximum sunlight. Ideally they should be in **full sun at least from 9am to 3pm**. In Australia, solar modules should face north for optimum electricity production.

Elevation

For grid-connected systems, the angle should match the latitude to maximise the amount of energy produced annually. This is about 35 degrees in Victoria.

However, if the electricity load is significantly higher in summer, your installer may consider angling the modules at a lower angle to maximise electricity production to match this load.

Customisation

If your roof's slope is not ideal, your designer can create an appropriate mounting frame to correct the orientation and elevation of your array. Failing this, the designer can advise you on how much output you are sacrificing from the array.

Australian Standards and industry guidelines

Solar grid-connected power systems must comply with a range of Australian Standards covering the grid connection of energy systems.

Average daily production

Electricity is metered in kilowatt hours (kWh). Hence if you use 1 kW for 1 hour you have consumed 1kWh of energy. Some electrical retailers refer to 1 kWh as 1 unit. The average electricity production from a 1 kW solar system in Victoria is about 1,230 kWh per year.

Getting a quotation

If asking for a quotation, you should make sure to request specifications, quantity, size, capacity and output for the major components, including:

> solar PV modules
> mounting frames or structure
> inverter
> travel and transport requirements
> other equipment needed
> any trench digging
> a system user manual
> warranties for all parts and labour.

The quotation should also specify a total price and the basis for any discounts for Renewable Energy Certificates or volume bulk buying groups.

Electricity distributors

All poles, lines and meters are provided by an electricity distribution business. You cannot choose your distributor as they are allocated geographically throughout Australia.

Electricity retailers

Electricity itself is sold to you, or bought from you, by an electricity retailer. In most states you can choose your retailer, although not all will agree to sell or buy from a solar-powered generator. It is important to shop around for the best deal with an electricity retailer, including buying rates and conditions.

Before signing with a retailer, check all the following:

> cost of electricity you purchase in cents per kilowatt hour
> price they will pay per kWh for electricity you feed into the grid
> penalty clauses, including termination costs
> billing/payment periods.

Renewable Energy Certificates for solar systems

Small solar PV systems are eligible to create Renewable Energy Certificates under the Commonwealth Government's Mandatory Renewable Energy Target. The certificates have a market value that can be worth thousands of dollars.

In most cases, the business selling you a new solar system may offer a discounted price on the basis of you signing over the rights to these certificates. You can choose to retain the certificates if you prefer.

The certificates are deemed to reflect the amount of renewable energy generated over a period of up to 15 years and a formula is used to calculate the number of certificates attributable to each solar system.

Up until 30 June 2012, the following applies:

1. **For the first 1.5 kW of installed solar energy:**

   Number of RECs =
   1.185 x kW rating of PV x 5 x 15 years.

   So, for 1.5 kW this is:

   1.1851 x 1.5 x 5 x 15 = 133.31
   = 133 (rounded down)

   In July 2009, RECs were worth about $40 so a 1.5 kW solar system would create RECs with a value of $5,320.

2. **For solar PV systems that are larger than 1.5 kW the additional capacity is credited with RECs at a lower rate.**

   Additional RECs =
   1.185 x kW rating in excess of 1.5kW x 15

Feed-in tariffs

A mandatory feed-in tariff is a rate (in cents per kWh) at which the electricity retailers are obliged to purchase electricity from your system. Victoria proposes legislation that requires payment of 60 cents per kWh for electricity exported to the grid. Check with your installer whether this is applicable and ensure you have installed a suitable electricity meter to account for your exported electricity.

FAQs

Q. What is the typical cost of a grid-connected PV system?

A. Historically systems have cost about $13,000 for 1 kW before allowances for rebates and RECs. More recently, lower costs have been achieved with some installers offering group buy schemes.

Q. Will the system provide power during a black out?

A. Most grid-connected solar power systems do not provide power during a black out. For safety reasons, when the 'grid goes down' your solar PV system must automatically and immediately turn off.

Q. Do all solar modules perform equally?

A. Differing panels each rated at the same maximum power should produce the same maximum power under equal sunlight conditions. Maximum power is measured in peak watts (Wp). What varies is the amount of roof space required for a given power production. The length of warranty offered is a good indicator as to how confident you should be about the product quality.

Bushfire safety consideration

The only bushfire safety issue associated with installing a PV system arises from roof penetrations for fixing.

Any gaps greater than 3mm must be sealed and in higher BAL zones, both unit and supports be non-combustible.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 4.01 July 2009

Sustainability victoria

Victoria The Place To Be

> solar hot water

Included in this fact sheet:

> **Benefits of solar hot water**
> **Choosing the right system**
> **Costs and installation**
> **Maximising performance**

This fact sheet provides information on the different types of solar hot water systems available, how they work, and practical issues to consider when purchasing one for your home.

What are the advantages?

Using the sun's energy to heat water can reduce your household hot water bills by more than 60% each year – a saving of $290-600 for the average family. This could add up to thousands of dollars saved over the lifetime of your system.

Solar hot water systems also help conserve our natural resources and the environment, and reduce greenhouse gas emissions.

Solar hot water technology is both sophisticated and well proven, and works very effectively in Victoria. Solar water heaters are generally equipped with gas or electric boosters to ensure that you are never without hot water.

How does it work?

Solar hot water systems use the sun's energy to heat water in much the same way as water in a hose left on the lawn gets hot on a sunny day.

An auxiliary heater is included in all solar hot water systems to boost the water temperature on days when solar energy may be insufficient to meet all your hot water requirements. Solar hot water manufacturers produce models with boosters that may run on electricity, gas or solid fuel, e.g. a wood heater or stove.

The main parts of a solar hot water system are the water storage tank and the solar collectors that absorb heat from the sun.

There are two typical types of solar collectors available:

Flat Plate Collectors consist of a blackened metal absorber plate within a glazed and insulated metal box (flat-plate collector). Pipes attached to the absorber plate carry liquid that is heated by the sun. In a direct heating system, water is heated as it circulates through the flat, glazed panels. In indirect systems, the sun's energy heats a glycol fluid that cannot freeze, which, in turn, heats the water in the tank.

Evacuated Tube Collectors consist of a series of long glass cylindrical tubes that contain a metal pipe that transfers heat into a manifold at the top of the collector.

Collectors should be positioned on the roof facing north (no more than 45° east or west of north) at a tilt angle between 15° and 50° (standard roof pitch is usually sufficient). If the roof does not face north, a mounting frame can often be used to position the solar collector for maximum advantage.

The storage tank can be located either on the roof directly above the collectors or on the ground (like a conventional hot water system).

What systems are available?

Close-coupled thermosyphon (mains pressure)

These systems consist of roof-mounted solar collectors, combined with a horizontally mounted storage tank located immediately above the collectors.

Heated water rises naturally through the solar collectors and enters the storage tank. When this happens, cooler water at the base of the storage tank is forced out and flows down to the bottom of the collectors. This cycle is continuously repeated while the sun is shining. Most commercially available solar hot water systems employ this cycle, commonly referred to as 'thermosyphon flow' (see Figure 1).

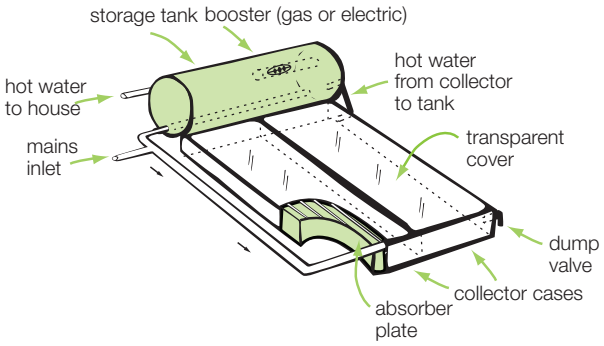


Figure 1: Close-coupled thermosyphon (mains pressure)

Remote thermosyphon system (constant [low] pressure)

This system works on the same principle as the close-coupled thermosyphon system, except that the storage tank is located within the roof space and supplies hot water by constant rather than mains pressure. The base of the tank must be situated at least 300 mm above the collectors (see Figure 2). This type of system can often use a wood heater as a booster.

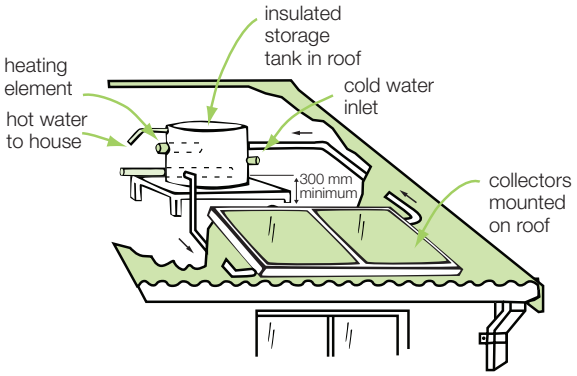


Figure 2: Remote thermosyphon system (constant [low] pressure)

Forced circulation system (mains pressure pumped)

With a forced circulation system, the tank is located below the level of the collectors, usually at ground level. Water must therefore be pumped from the tank to the collectors and back by a thermostatically controlled pump. These pumps are not expensive to run, costing about $10 a year. This system can be used when the roof structure is not strong enough to support the weight of a water tank. (see Figure 3).

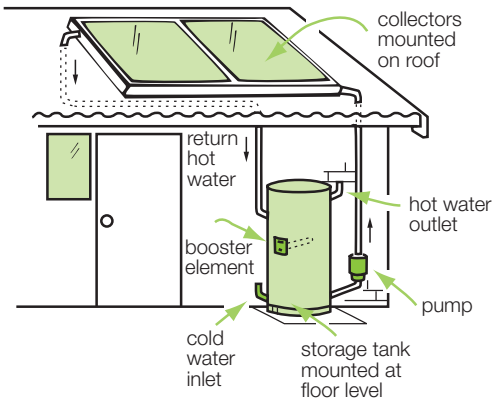


Figure 3: Forced circulation system

Continuous flow gas-boosted systems

A continuous flow gas water heater designed to cope with varying (and often quite high) input temperatures can also be used as a solar hot water booster. In this configuration, the solar hot

water heater preheats the water and the gas heater is only used if the water temperature becomes too low. This minimises the amount of gas required to heat the water and maximises the contribution from the sun (see Figure 4).

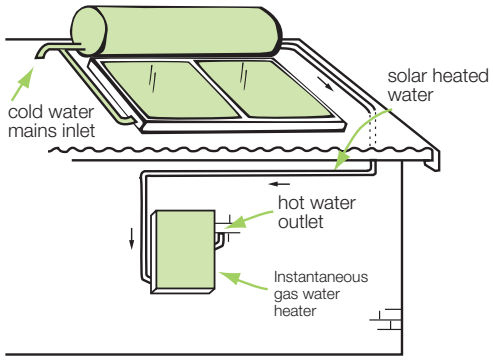


Figure 4: Instantaneous gas water heater connected to a close-coupled solar preheater

Heat pumps

Heat pumps are another type of hot water system that run efficiently on electricity. These systems use a refrigerant gas and a compressor to extract heat from the surrounding air. This is sometimes called 'air source' heat. The gas then moves along to a coil that is wrapped around the hot water tank where it condenses and gives off the heat it has absorbed to the water in the tank.

Heat pumps are included as electric-boosted solar water heaters as they require similar amounts of electricity to operate.

What type of tank should I purchase?

Storage tanks for solar hot water systems are generally made from stainless steel, copper (low pressure systems only), or mild steel with a coating of vitreous enamel (mains pressure).

Vitreous enamel-lined tanks have a 'sacrificial anode' that is designed to reduce corrosion of the tank. These anodes require periodic checking and replacement every 5-7 years on average.

The life expectancies of storage tanks are often reflected by the length of the warranty period offered. Check this with the manufacturer or supplier.

Frost protection

It is important in cold colder climates to ensure that your solar how water system has a form of frost protection.

1. Passive forms of protection include use of an indirect heating system (some form of heat exchanger) or frost protection valves. Frost protection valves are cheaper but less reliable than using a heat exchanger.

   Indirect heating systems are recommended for areas that are susceptible to frost. In this kind of system, water that has been treated with some form of anti-freeze (such as glycol) is run through the collectors. The heat that is absorbed from the sun into the anti-freeze is transferred by the heat exchanger into the water in the storage tank. The anti-freeze treated water is kept totally separate from any water used for domestic purposes.
2. Active systems use pumps to circulate water through the collectors when the temperature drops below a certain point. In areas where the power supply is unreliable, this could be a risky option, as the pump will not operate if the electricity supply is off.

What size system will I need?

The following table can be used as a guide to choosing the right size of solar hot water system for your needs, however you should consult your supplier for specific size recommendations.

Number of persons served	Capacity (litres)	Collector area (m^2)
1-2	160-200	2
3-4	300-370	4
5-6	440	6

How much does it cost?

Solar water systems vary in price depending on the model, tank size and number of panels. It is often possible to negotiate discounts when purchasing solar hot water systems.

A list of accredited solar water heaters and recommended retail prices is available on our website: resourcesmart.vic.gov.au/for_households_3381.html or contact info@sustainability.vic.gov.au for more information.

Is it a good investment?

In terms of the environment and reduction of greenhouse gas pollution, solar hot water is an excellent investment and should be considered. However, to determine whether or not solar hot water is a good financial investment, the following factors need to be considered:

> geographic location
> hot water usage
> system performance
> type and cost of system
> type of auxiliary heating used.

For an additional investment of around $2,000 above the price of a conventional hot water system, a solar hot water system in Melbourne will pay for itself in approximately four to ten years at today's gas and electricity tariffs. This period will be shortened if tariffs rise. Government commitments to reduce Australia's green house gas emissions means that large financial subsidies are available.

Solar hot water rebates

The Victorian Government offers rebates of up to $1,600 for people replacing non-electric hot water heaters with gas boosted solar hot water systems. For more information contact Sustainability Victoria's information line on 1300 363 744.

FAQs

Will I get power and hot water from this system?

No. Solar hot water panels only heat water that is stored in a tank.

Does solar hot water work in cooler climates?

Yes. In fact, most solar water heating in Victoria is done in the cooler southern regions. Solar collectors work at lower air temperatures because evacuated tube collector types can be more suited to cold climates.

Will I run out of hot water?

No. Solar hot water systems are designed to store larger amounts of hot water than conventional systems. A correctly sized system will have hot water left over from the previous day. If you have a few cloudy days in a row, the thermostat will turn the booster on to bring the water up to temperature.

Is it a good investment?

A new solar hot water system always pays back the difference in cost over the life of the system. The chart below shows the typical running costs for LPG, solar with electric boost, and electric heat pump hot water systems;

Annual Running Cost

	Annual running cost for 200 litres per day
Standard electric HWS	$745 to $755
LPG hot water	$920 to $1,090
Natural Gas 5-Star HWS	$225 to $235
Electric heat pump HWS	$185 to $315
Solar – electric boost	$85 to $315
Solar – LPG boost	$115 to $465
Solar Natural Gas Boost	$35 to $120

Not included in these calculations is the fact that solar hot water systems last longer than conventional hot water systems (15-20 years). A solar hot water system can also add value to your home.

A short payback period can be expected in areas with higher levels of solar radiation (e.g. north of the Great Dividing Range) or where the alternative fuel source is more expensive (e.g. LPG).

Important considerations

To get the most out of your solar hot water system, make sure:

- you carefully read the warranty details (check that it includes frost protection)
- your roof's structural strength is assessed (by the installer) to ensure that it can support the weight of the system
- solar collectors will not be shaded by trees or nearby buildings
- the storage tank and solar collectors are as close together as possible to reduce the length of the connecting pipes (in constant pressure and pumped systems)
- all pipes are well insulated
- some form of frost protection is included
- all plumbing is carried out by a licensed plumber. The plumber will issue a certificate of compliance
- all electrical work for the installation of electrical heating elements and electric pumps is carried out by a registered electrical contractor. The contractor will issue a certificate of electrical safety
- if your water quality is poor, then you need to be aware that the system's warranty may be affected.

Tips for better performance

The most effective way to obtain maximum performance from your solar hot water system is to make efficient use of hot water in your home. Things you can do include:

> when possible, do jobs requiring hot water early in the day. This allows the water remaining in the tank to be reheated by the sun and reduces the auxiliary heating period

> keep the booster thermostat at its recommended setting of 60°C. Remember, the lower the thermostat setting, the less energy used to supplement solar heating

> install your system as close as possible to the kitchen, bathroom and laundry, which are the main hot water draw-off points around the home. If this is not possible, install it close to the kitchen

> conserve hot water by using it efficiently

> fit a low flow showerhead. Showering accounts for over 30% of hot water usage in the home. This can be dramatically reduced by fitting a low flow showerhead, or a flow restrictor to an existing showerhead

> make sure you follow the manufacturer's recommendations for the maintenance of your solar hot water system.

Bushfire safety considerations

The only bushfire safety issues associated with installing solar hot water systems arise where they are not sitting flush on the roof.

In these cases, any gaps greater than 3mm must be sealed and in higher BAL zones, both units and supports must be fully non-combustible.

Further information

resourcesmart.vic.gov.au

sustainability.vic.gov.au

www.saveenergy.vic.gov.au

www.greenplumbers.com.au

www.yourhome.gov.au

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 4.02 July 2009

Sustainability victoria

Victoria The Place To Be

Water

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> water efficiency

Included in this fact sheet:

- > Water efficiency around the home
- > How much can you save?
- > Efficient appliances
- > Water recycling
- > Water efficient gardening

This fact sheet presents background information relating to water – how we use it, why we need to save it and what we can do to minimise its use around the home. Here, you'll also find useful tips on smart water planning and advice on keeping up to date with the latest water saving rules.

Why save water?

Water is essential to our everyday lives: we use it for drinking, washing and watering – the very basic human needs. Our communities thrive on it, our economy relies on it, and our environment depends on it.

In Victoria, our water supplies are facing the growing challenges of climate change – less rainfall, hotter days, changing rain patterns and reduced stream flows. These factors, combined with an increasing population, have put stress on our water supply, leading to water restrictions in many areas.

By reducing our water use, every individual can contribute to saving water so that future generations can thrive as we do today. More immediately, saving water also saves you money on your water usage and often your energy bill too.

Where can I save water around the home?

As seen in the chart below, there are many areas where we use significant amounts of water around the home. Inside a typical house, showers, clothes washing machines and toilets account for more than 60% of the total water used. The amount used in the garden varies greatly depending on the size and type of garden and the time of year.

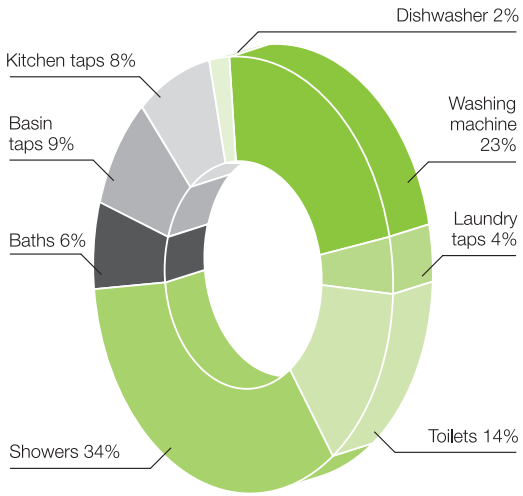

Figure 1: Typical breakdown of indoor water use in a new four bedroom home with a garden

Savings in water use can be achieved across all activities in the home. Focus on the largest uses first (showers, toilets, clothes washing machines and gardens) as these will realise the biggest gains. Remember, it is much easier and usually cheaper to integrate improvements into new buildings and renovations than to retrofit at a later date.

Look for synergies across the home too. For example, you can reuse greywater from the bathroom and laundry on the garden.

Find out more at resourcesmart.vic.gov.au

How much water could I save with smart water planning?

On average, a family of four in a new house with a garden on a typical development block (600 square metres) will use around 240,000 litres of water a year. This is enough to fill nearly five typical sized swimming pools. Figure 2 below shows potential water savings of around 34,000 litres or 17% from combining three simple efficiency measures: 4 star toilets, a hot water recirculator and a front loading washing machine.

	Base Case kl/yr	Efficient Case kl/yr	kl/yr saved	% of Base Case saved
Washing Machine (a)	45.1	26.3	18.8	42%
Laundry taps	8.1	8.1	0.0	0%
Toilets (b)	27.6	23.0	4.6	17%
Showers (c)	65.3	55.1	10.2	16%
Baths	12.5	12.5	0.0	0%
Basin taps	16.8	16.8	0.0	0%
Kitchen taps	15.6	15.6	0.0	0%
Dishwasher	4.5	4.5	0.0	0%
All indoor	195.5	161.9	33.6	17%
Garden	45.0	45.0	0.0	0%
Total	240.5	206.9	33.6	14%

Figure 2 - Examples of savings from more efficient water use

(a) Efficient case = front loader instead of a top loader

(b) Efficient case = 4.5/3 litre flush instead of 6/3 litre flush

(c) Efficient case = installation of a hot water recirculator

How can I save water?

To effectively reduce how much water you use, you will need to do a variety of things, including:

> change your habits and behaviour to avoid using water – cutting your shower time down to four minutes, for example

> buy appliances and fittings that are more water efficient

> reuse as much water as possible and replace potable water with an alternative water source where appropriate

> design a water efficient garden

> design your house to promote water efficiency.

Change your habits

The easiest way to save water is through changing the way you use water. This can often be done at little or no cost and once it becomes a habit, it is long lasting. For example:

> take shorter showers

> take a shower instead of a bath

> brush your teeth without running water

> use the partial flush button on your toilet

> wait until you have a full load for your washing machine or select a lower water level for smaller wash loads

> use the dishwasher only when it's full

> don't rinse your dishes if they are to go into the dishwasher

> install a pool cover for swimming pools and spas.

Buy water efficient appliances

There are many appliances on the market today that offer water efficient alternatives – some examples of which are offered in the list below. For more information, see Sustainability Victoria's Water Efficient Appliances fact sheet and the links at the end of this fact sheet.

> Low flow showerheads
> Efficient water heating systems
> Hot water recirculation systems
> 3–star water rated taps
> Dual flush toilets
> Waterless toilets
> Water efficient front loader washing machines instead of top loaders
> Water efficient dishwashers
> Drip irrigation systems
> Garden irrigation timers

Because it can be confusing to work out which particular appliance model is more water efficient, the Water Efficiency Labelling and Standards (WELS) Scheme has been developed. This rating scheme applies mandatory water efficiency labelling and minimum performance standards to household water-using products. It is mandatory across Australia for showers, clothes washing machines, dishwashers, toilets and urinals, as well as taps.

The WELS Rating label on each appliance includes:

> a star rating that gives a quick comparative assessment of the model's water efficiency
> a water consumption figure that provides an estimate of the water consumption of the product based on its tested water consumption.

Labels display from 1 to 6 stars – the more stars, the more water efficient the product. Some products may also be labelled with a 'Zero Star Rated' label, which indicates that the product is either not water efficient or does not meet basic performance requirements.

Water recycling and reuse

The water supplied through a mains system has been treated to a very high standard to ensure it is safe to drink. However, many of the uses around the home, in particular toilet flushing and garden watering do not need such high quality water. Significant reductions in drinking water use can be made when the water used is 'fit for the purpose' required.

In Victoria the most common alternatives to drinking water are:

> rainwater collected off roofs and stored in tanks
> class A recycled water via a third or dual pipe system
> treated or untreated greywater
> stormwater and dam water
> bore water.

Whatever alternative water source you are going to use, be sure to seek advice from your local water corporation, nursery or appliance supplier to ensure it can be used for the desired purpose. Figure 3 overleaf is a good guide for the use of some alternative water sources. (Bore water has not been included, as the quality will vary widely depending on location.)

Figure 3 - Use and benefits of alternative water supply options, Class 1 dwellings

	End use	Rainwater	Recycled (Class A)	Greywater: untreated	Greywater: treated (c)	Stormwater
Least sensitive	Toilet flushing	Yes	Yes	No	Yes	Yes
	Sub-surface landscape irrigation	Yes	Yes	Yes	Yes	Yes
	Surface landscape irrigation	Yes	Yes	Possible[b]	Yes	Yes
	Food crop/vegetable irrigation	Yes	Yes	No	Yes	Yes
	Outdoor uses such as car washing	Yes	Yes	No	Yes	Yes
	Cold supply to clothes washer	Yes	Yes	No	Yes	Possible[b]
	Swimming pool and spa pools	Yes	No	No	No	Possible[b]
	Evaporative coolers, fountains	Yes	Possible[b]	No	No	Possible[b]
	Cold water supply to dishwasher	Yes	No	No	No	Possible[b]
	Personal washing (hot & cold)	Yes	No	No	No	Possible[b]
Most sensitive	Drinking, cooking (hot & cold)	Yes[a]	No	No	No	No
Provides stormwater retention benefits		Yes	No	No	No	Yes
Need for management by the user and regular drawoff to maintain storage capacity		High	No	High	Med	High

Consistent with (DSE 2006)

(a) Where a reticulated drinking water supply is available, it is recommended that the supply be used for this purpose

(b) These uses would be subject to controls to manage potential risks

(c) Greywater would need to be treated to minimum standards for certain uses

When choosing an alternative water source – in particular greywater or rainwater – some points to remember are:

> the size of your rainwater tank will depend on what you are going to use the water for, the roof area available for collecting water and your household size. For example, if your tank is for garden use then it will need to be larger than if it is going to be used inside the house for toilet flushing. For more information, see Sustainability Victoria's Rainwater Tank fact sheet
> untreated greywater cannot be stored for more than 24 hours and should not be used for growing vegetables. For more information, see Sustainability Victoria's Recycled and Greywater fact sheet
> your choice of garden plants is extremely important. Consult your local nursery for advice.

Water efficient garden

There are many different actions you can take to save water in your garden. Your choice of action will depend on your location, the size and type of your garden, and the plants you wish to grow. Some of the things you can do include:

> plant indigenous or drought resistant plants acclimatised to your area
> use mulch to prevent water loss
> fertilise appropriately to encourage healthy plants
> introduce shading by planting trees or using other structures
> install a water efficient irrigation system to water your garden
> include an appropriately sized tank in your garden design
> use an alternative source of water such as rainwater, recycled or greywater to irrigate your garden.

Housing design

Housing design can play an important part in reducing water use. For example:

> the orientation of your house and use of insulation can reduce or even eliminate the need for air conditioning
> plan the layout of your home so the water heater is close to where hot water is used
> position the plumbing outlets from the shower and laundry so they are easy to tap into for greywater
> design the roof to maximise rainwater capture
> provide enough space for an adequately sized rainwater tank.

Keeping abreast of water saving rules

It is vital to have an up-to-date knowledge of Victoria's Permanent Water Saving Rules when you are planning and selecting your watering system. You can check current water restrictions at www.ourwater.vic.gov.au

Further information

> www.ourwater.vic.gov.au
Information on household water use, Victoria's Permanent Water Saving Rules, Waterwise Gardening and other developments.

> www.savewater.com.au
Information on suppliers of rainwater tanks, greywater systems, water efficient irrigation products, hot water recirculators and other water saving equipment.

> www.waterrating.gov.au
Information on the Water Efficiency Labelling and Standards (WELS) Scheme, including the water star ratings of clothes washers, dishwashers, taps, shower heads, toilets, urinals and flow control valves.

> www.wsaa.asn.au/smartwatermark/approved.htm
Information on the Smart Approved WaterMark, a labelling program for outdoor water saving products and services.

> www.epa.vic.gov.au/water/
Guidance on alternative water supplies and water recycling.

> www.buildingcommission.com.au/www/html/390-5-star-standard-for-all-new-homes.asp
Information on the water and energy saving building requirements in the 5 Star Standard for all new homes.

> http://conservewater.melbournewater.com.au
Guidance on good household water conservation practices.

> www.greenplumbers.com.au
Information on licensed GreenPlumbers® businesses that can provide services including environmentally sustainable plumbing, construction work, gas work, heating and cooling work or products using certified GreenPlumbers®.

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 5.01 July 2009

Sustainability victoria

Victoria The Place To Be

> water efficient appliances

Included in this fact sheet:

- > Why buy water efficient appliances?
- > How to use labelling to choose the most efficient appliances
- > What sorts of appliances use the most water?
- > Where can I find more information?

This fact sheet explains the many benefits that water efficient appliances can offer, together with handy tips for choosing the right appliances for your home.

Why buy water efficient appliances?

Household appliances are responsible for a significant amount of water used around our houses. Water efficient appliances not only reduce the amount of water used, they also help reduce water bills and are often more energy efficient, which means lower energy bills as well.

In addition, it is a Government requirement that all new homes built in Victoria include water saving measures such as water efficient showers and taps. Water efficient appliances can be more expensive initially, but will cost less to run and save money on your water and energy bills.

How do I know which appliances to buy?

Ultimately, the appliances you choose to buy will depend on a range of factors including cost, availability, personal preference and the size of your house and your family.

The national Water Efficiency Labelling and Standards (WELS) Scheme has been developed to help you factor in the water efficiency of the appliance when making your choice.

This rating scheme applies mandatory water efficiency labelling and minimum performance standards to household products that use water. In Australia, it is mandatory for showers, clothes washing machines, dishwashers, toilets, urinals and taps.

The WELS Water Rating label on each appliance includes:

- > a star rating that gives a quick comparative assessment of the model's water efficiency
- > a water consumption figure that provides an estimate of the water consumption of the product based on its tested water consumption.

Labels display from 1 to 6 stars – the more stars, the more water efficient the product. Some products may also be labelled with a 'Zero Star Rated' label, which indicates that the product is either not water efficient or does not meet basic performance requirements.

What appliances to buy?

Your biggest savings will come from focusing on appliances that use the most water. As shown in Figure 1 overleaf, around 34% of indoor water is used in showers and 23% in clothes washing machines. This is followed by toilets, bathroom and kitchen taps, the bath and laundry taps.

The efficiency of appliances has been increasing in recent times. For example, many of the new dishwashers use less water than washing up by hand when you program them efficiently. It is also worth noting that showers also use 50% of all the household hot water so reducing shower times will also reduce hot water use and associated bills.

Find out more at resourcesmart.vic.gov.au

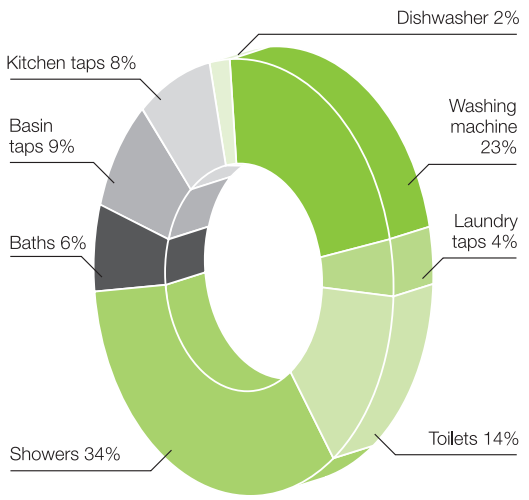

Figure 1 - Typical breakdown of indoor water use in a new 4-person home with garden

Showers

All shower heads installed in new homes with a mains water supply must have a maximum flow rate between 7.5 and 9 litres per minute under standard test conditions. This corresponds to a WELS rating of 3 stars. The use of low flow showerheads and shorter showers can deliver significant savings in both water and energy usage.

Toilets

All toilets fitted into new homes where the property is connected to the mains drinking water supply must have both a full and partial flush option (i.e. dual flush). Most commonly, toilets will be 6/3 meaning they have a 6-litre full flush and a 3-litre partial flush. This gives them an average flush volume of 3.6 litres and a 3 star WELS rating.

However, some manufacturers have introduced 4.5/3-litre dual flush toilets, with an average flush volume of 3.3 litres. This is a 4 star WELS rating and works just as well as the 6/3 type. They are cost competitive and can save around 5,000 litres of water per year in a home occupied by four people.

Clothes washing machines

The two main types of washing machines are front loaders and top loaders. Front loaders use less water because the clothes are tumbled through a pool of water at the bottom of a drum. On average, they use about half as much water as a top loader for the same wash load. This can result in savings of around 20,000 litres of water each year for a family of four.

The WELS ratings are a good guide when determining which machine to buy. Most water efficient clothes washing machines on the market have at least a 4-star WELS rating. Issues to consider when making your choice include:

> the capacity of the machine – many machines let you select a lower water level for a smaller wash load, but the amount of water used per kilogram of clothes increases if the machine is not fully loaded. It is more water and energy efficient to choose the right sized machine and to only wash full loads

> the wash cycle used to determine the star rating – make sure it is the cycle you are most likely to use

> does the machine heat its own water or is it connected to the hot water system? Machines that heat their own water will use more energy. However, this is not a problem if you choose to wash only in cold water

> is the machine going to be connected to the mains drinking water supply or an alternative water source such as rainwater, third pipe recycled water or bore water? Advice should be sought from the manufacturer as some water sources can cause corrosion.

Taps

All taps installed in bathrooms, kitchen and laundries of new homes connected to a mains water supply must have a maximum flow rate of between 7.5 and 9 litres per minute. This corresponds to a 3-star WELS rating.

Although there are many taps with star ratings above 3, keep in mind that:

> the lower flow rate is no advantage for taps used to fill sinks or baths because they use the same volume of water and it simply takes longer to fill

> very low flow rates may not activate some instantaneous gas water heaters and you may not get any hot water from the tap. This is not such a problem if you plan to have a storage water heater.

Dishwashers

Most new dishwashers are very water efficient and use between 15 and 20 litres per cycle (two to three sinks full of water). Running a water efficient dishwasher once a day can use around the same amount of water as washing and rinsing dishes by hand in the sink.

The key to using a dishwasher efficiently is to run it only when it is full. A partial load uses exactly the same amount of water as a full load.

When choosing a dishwasher, use the WELS stars as a guide, but ensure that the cycle used to determine the WELS rating is the same cycle as you are most likely to use.

Cost, energy use, noise level and size are other factors that need to be considered. There is a range of models designed for a variety of family sizes and choosing the one most appropriate for you will result in both energy and water savings. The most water efficient dishwashers on the market have a WELS of at least 3.5 stars.

It is recommended that all dishwashers should use mains water drinking supply where available. If there is not a mains connection and the only water available is tank or bore water, we recommend that you seek advice from the supplier as some water sources can cause corrosion.

Hot water heaters

Most of the water loss associated with hot water heaters is from water wasted while waiting for the hot water to reach the tap. The delay varies with the type of water heater, the distance to the outlet and the pattern of draw-offs, but it's usually from 15 seconds to three minutes. On average, this wastes between 2-24 litres of water each time the hot tap is turned on.

There are a number of options available to reduce this loss:

> plan the layout of your home so that the water heater is closer to where hot water is used. If your bathroom is a long way from the main water heater, consider installing a separate bathroom water heater

> consider a circulation pump that circulates the hot water during peak periods of water use in the morning and at night. Hot water flows past every hot tap, so there is no waiting time when one is turned on. The circulating pump is controlled by a time clock and a temperature switch so the pump only operates if the water in the loop has cooled

> consider 'conscious' or 'on demand' re-circulators that are activated by a button on a control panel next to the shower or tap. If the water is still hot from the last use, a light indicates that hot water is available at the tap. If the water in the loop has cooled, the pump circulates water by a return loop through the water heater to bring it up to temperature

> use an automatic diversion of sub-temperature water into the cold water supply so that water only comes out of the hot tap when it reaches the desired temperature. The diverted water can go back into the mains cold supply if the system allows it, or to flexible bladders or a rainwater tank. Some designs work by differences in pressure while others require pumps.

Most of these options require pumps and possibly temperature control, and some will need storage tanks. Several manufacturers offer on demand re-circulators designed to work with the electronic controls of their gas water heaters. These add about $800 to the initial cost if they are installed when you are building your home.

In Victoria, water heaters are the second highest home energy users after space heating, so it's important to think carefully about how you are going to heat your water. For more information on the type of heater to buy and different energy sources, please see the links at the end of this fact sheet.

Evaporative coolers

In many parts of Victoria, a well designed home will stay cool with good orientation, window shading and natural ventilation or ceiling fans. This vastly reduces the demand for cooling.

For homes that do need further cooling, there is a choice between refrigerated air conditioning and evaporative cooling. Refrigerated air conditioners tend to use more energy than evaporative, but do not need water to run. Evaporative coolers cool the air by passing it through water-saturated filters and work best in hot, dry conditions when humidity is low. But roof mounted evaporative coolers must be enclosed in perforated metal mesh in lower bushfire zones. They are not permitted in higher BAL zones.

Evaporative coolers vary in how much water they 'bleed' or send to waste while they are operating. They have a reservoir or sump that needs to be refilled as water evaporates, and as it is 'bled off' to maintain water quality. In many systems, the sump is emptied completely at the end of an operating cycle, which can last for several days.

To reduce the amount of water wasted, the following issues should be considered:

> choose a system with water quality conditioning and sensor control, where the bleed and dump rate are determined by the water quality rather than a set time period. In Melbourne, this can reduce water loss from around 10,000 litres to 6,000 litres
> choose a system with an adjustable bleed valve set by the installer to reflect local water quality. Often the installer sets the period between dumps at higher bleed rates and more frequent dumps to minimise problems, rather than setting to optimise local conditions
> optimise the size of the unit and sump to suit your house size and usage patterns
> capture the bleed water for garden use; if you choose to do this, first seek advice on salt tolerant plants from your local nursery.

Swimming pools and spas

Evaporation causes most of the water loss from outdoor pools and spas. The evaporation rate depends on exposure to sun and wind.

You can reduce evaporation from a swimming pool or spa by:

> installing a pool or spa cover to keep dust and leaves out, cut down on filter and chemical use and retain heat (helping to extend the swimming season by up to three months)
> installing solid fencing and planting on the side of the prevailing wind
> installing shade cloth or permanent structures over part of the pool and spa.

Plan your pool's shape for easy covering. A more complex shape is more expensive to cover and harder to roll and unroll.

Motor-driven rollers are available and can be located underwater so there is no intrusion into the above-pool area at all. These systems are more expensive but have safety advantages.

Bushfire safety notes

The only bushfire safety issue relating to water efficient appliances arises from the use of roof-mounted evaporative coolers.

In lower BAL zones, these covers must be enclosed in perforated metal mesh. They are not permitted in higher BAL zones.

Swimming pools may provide a useful Static Water Supply (SWS) at times of bushfire emergency.

Further information

> www.ourwater.vic.gov.au
Information on household water use, Victoria's Permanent Water Saving Rules, Waterwise gardening and other developments.

> www.savewater.com.au
Information on suppliers of rainwater tanks, greywater systems, water efficient irrigation products, hot water re-circulators and other water saving equipment.

> www.waterrating.gov.au
Information on the Water Efficiency Labelling and Standards (WELS) Scheme, including the Water Rating star ratings of clothes washers, dishwashers, taps, shower heads, toilets, urinals and flow control valves.

> http://conservewater.melbournewater.com.au
Guidance on good household water conservation practices.

> www.greenplumbers.com.au
Information on licensed GreenPlumbers® businesses that can provide services including environmentally sustainable plumbing, construction work, gas work, heating and cooling work or products using certified GreenPlumbers®.

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ENV015 5.02 July 2009

Sustainability victoria

Victoria The Place To Be

> recycled water and greywater

Included in this fact sheet:

- > What is recycled and grey water?
- > What can I use recycled and grey water for?
- > What are the benefits of recycled water and greywater?
- > Where can I find out more?

This fact sheet provides an introduction to recycled water and greywater, and explains how it can be used around your home and how it can help you cut your water usage and protect the environment.

What is the difference between recycled water and greywater?

Recycled water

Recycled water is wastewater that has been treated to a high standard at a treatment plant and then distributed in separate pipes from the mains water supply. This is known as a third pipe or a dual-pipe system. A recycled water system can be easily distinguished from a drinking water system as purple coloured pipes and fittings are used.

Recycled water is not suitable for drinking. However, it can be used for toilet flushing and garden watering.

Greywater

Greywater is the wastewater from clothes washing machines, showers and taps from most areas within the house, except kitchens and toilets. It is generally reused on the same property.

Greywater is not suitable for drinking. However, it can be used for toilet flushing and garden watering.

What can I use it for?

Recycled water

Recycled water supplied through a third pipe system has been treated to Class A standard to minimise any health risks. It is most commonly used for toilet flushing and garden watering, but can also be used for other purposes as shown in Figure 1 overleaf.

We recommend that you seek advice from your water authority and appliance manufacturer before using recycled water in your clothes washing machine or evaporative cooler. We also recommend that you approach your local nursery for advice on suitable plants for your garden if you plan on watering it with recycled water.

The taps and fittings are purple to ensure that the recycled water supply is not confused with the drinking water supply. Recycled water taps also have removable handles to make sure that children don't come into contact with recycled water or drink it while they are playing in the garden.

A third pipe recycled water supply provides a constant source of water that usually is slightly cheaper than drinking water. It is metered separately from your drinking water by your local water corporation.

Untreated greywater

The simplest way to use greywater is to install a diverter that captures water directly from sources such as the clothes washing machine, shower or bath for use on the garden. This untreated greywater must be used within 24 hours because of the risk of bacterial growth.

Find out more at resourcesmart.vic.gov.au

Some systems will include a filtering system and a safety mechanism so that if the outlet pipe gets blocked, a diverter will automatically switch to discharge the greywater to the sewer or septic tank.

Because it is untreated, this greywater is most commonly used on the garden and is better used through a subsurface irrigation system than a spray irrigation system. This is to reduce the risk of contact with humans, pets and sensitive plants. It should not be used on vegetables and herbs. Contact your local nursery or the websites listed below for more advice on suitable plants.

Some things to remember when using untreated greywater:

> minimise the potential adverse effects of greywater on plants by choosing low salt, liquid detergents – these have much lower salt levels than powders
> keep track of what is in the wash – for example, the wash water from soiled nappies should not be sent to the garden
> divert the wash water to the sewer and reuse the rinse water, which is much less contaminated.

Capturing greywater from showers and baths is more difficult because it is necessary to collect water from taps at floor level and the diverter cannot be located directly below the sources. The increased supply may be difficult to absorb usefully unless you have a very large garden.

Treated greywater

Greywater can also be treated through various systems to reduce the health risks. Key features of most treatment systems include:

> a tank of similar volume to a rainwater tank and used in much the same way
> significantly higher costs than a rainwater tank
> a regular supply of water, which is not dependent on rainfall
> higher plumbing costs – laundry and bathroom sub-floor wastes must be diverted to the greywater system, and overflows diverted to the sewer
> a treatment unit, controller and pump, all connected to power.

Once treated, there are no restrictions on using greywater in the garden as any health risks are greatly reduced. It is typically suited for the same purposes as third pipe recycled water as shown in Figure 1. It is, however, still important to differentiate between greywater taps and fittings and those supplying drinking water to avoid cross contamination and accidental exposure.

The treatment process does not remove salt and other chemical contaminants so it is still important to use low salt detergents to minimise adverse effects on plants.

The cost of a greywater treatment system can vary depending on the complexity of the system. Most will also include costs for the ongoing operation and maintenance of the system. For more details, consult a local supplier.

What are the benefits of using recycled or greywater?

Drinking water supplied through the mains system has been treated to a very high standard to ensure that it is safe to drink. However, many uses around the home – particularly toilet flushing and garden watering – do not need such high quality water. You can significantly reduce the amount of drinking water used around your home by using alternative sources of water that are 'fit for purpose'. Figure 1 lists the quality of water appropriate for common household uses. More information can be found through the links listed at the end of this fact sheet.

Figure 1 - Use and benefits of alternative water supply options, Class 1 dwellings

	End use	Rainwater	Recycled (Class A)	Greywater: untreated	Greywater: treated (c)	Stormwater
Least sensitive	Toilet flushing	Yes	Yes	No	Yes	Yes
	Sub-surface landscape irrigation	Yes	Yes	Yes	Yes	Yes
	Surface landscape irrigation	Yes	Yes	Possible[b]	Yes	Yes
	Food crop/vegetable irrigation	Yes	Yes	No	Yes	Yes
	Outdoor uses such as car washing	Yes	Yes	No	Yes	Yes
	Cold supply to clothes washer	Yes	Yes	No	Yes	Possible[b]
	Swimming pool and spa pools	Yes	No	No	No	Possible[b]
	Evaporative coolers, fountains	Yes	Possible[b]	No	No	Possible[b]
	Cold water supply to dishwasher	Yes	No	No	No	Possible[b]
	Personal washing (hot & cold)	Yes	No	No	No	Possible[b]
Most sensitive	Drinking, cooking (hot & cold)	Yes[a]	No	No	No	No
Provides stormwater retention benefits		Yes	No	No	No	Yes
Need for management by the user and regular drawoff to maintain storage capacity		High	No	High	Med	High

Consistent with (DSE 2006)

(a) Where a reticulated drinking water supply is available, it is recommended that the supply be used for this purpose

(b) These uses would be subject to controls to manage potential risks

(c) Greywater would need to be treated to minimum standards for certain uses

Apart from reducing drinking water use, there are a number of other benefits from using recycled water and greywater. They include:

> lower water bills
> less sewage discharged to the oceans and rivers
> an available water supply not subject to water restrictions
> the ability to maintain your garden through low rain periods.

Bushfire safety considerations

There are no bushfire safety issues associated with recycled water and greywater.

However, gardens and plants with higher moisture levels (from recycled water or greywater) will better resist bushfire attack.

Further information

> www.ourwater.vic.gov.au
Information on household water use, Victoria's Permanent Water Saving Rules, Waterwise gardening and other developments.

> www.savewater.com.au
Information on suppliers of rainwater tanks, greywater systems, water efficient irrigation products, hot water re-circulators and other water saving equipment.

> www.epa.vic.gov.au/water/
Guidance on alternative water supplies and water recycling.

> www.pic.vic.gov.au
Information on plumbing requirements for household water recycling and rainwater collection systems.

> www.greenplumbers.com.au
List of licensed GreenPlumbers® businesses that can provide services including environmentally sustainable plumbing, construction work, gas work, heating and cooling work or products using certified GreenPlumbers®

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 5.03 July 2009

Sustainability victoria
Victoria The Place To Be

> rain water tanks

Included in this fact sheet:

> Why put in a rainwater tank?
> What can rainwater be used for?
> How do I know what size tank I need?
> How do I know how much water I can harvest?
> Installation
> Maximising tank performance

Why put in a rainwater tank?

Collecting rainwater from your roof allows you to reduce your drinking water use and can provide you with additional water for use around the home in times of drought, particularly in the garden.

It will also reduce the amount of runoff from your property and help to protect our rivers and streams.

What can rainwater be used for?

Rainwater can safely be used for most purposes around the house including toilet flushing, clothes washing, evaporative coolers and gardening, including growing food crops. It can even be used in some hot water heaters though it is recommended to check with the supplier.

When the tank is connected to the house, special back flow prevention valves are installed so that if the tanks supply runs out it can be switched to mains water supply.

One big advantage of installing a rainwater tank is that in times of water restrictions it can be used to maintain gardens, wash cars and windows and top up pools.

Rainwater for drinking

Where a property can be connected to the mains drinking water supply, it is not recommended that rainwater be used for drinking. If it is not carefully managed, rainwater can contain contaminants washed off roofs and fittings (such as bird droppings and organic material).

However, where a mains water connection is not available, rainwater can successfully be used for drinking provided a few simple steps are taken:

> maximise tank size to provide adequate volume and detention time. It may be more feasible to install a series of smaller tanks than one large tank
> regularly inspect gutters and clean gutters of dirt and debris
> install a 'first flush' diverter and maintain it regularly. This diverts the first flow of a rain event away from the tank preventing contamination by debris and dirt from the roof and pipes. This is particularly important if your collection system includes a 'U' bend in the pipes where water sits in between rain events
> ensure your roof collection area does not contain lead-based paints, bitumen or tar coatings, treated timbers or other potential sources of contamination.
> ensure your tank is covered and inflows and outlets are screened to stop vermin and insects getting in
> ensure your tank is desludged every few years (through an inspection hatch that is secured to prevent child access).

For more information, please contact your local council or the following site: http://www.health.vic.gov.au/environment/water/tanks.htm

Find out more at resourcesmart.vic.gov.au

How do I know what size tank I need?

There are some general rules of thumb you can use as a guide to help determine the size of the rainwater tank that best suits your situation:

1. Rainfall intensity and frequency in your area – you can check this on the extensive rainfall data on the Bureau of Meteorology's website: www.bom.gov.au/climate/averages
2. Your home's roof catchment area and the percentage of this area that can be used to collect water.
3. The end use of the water – how much water you'll be using, what you'll be using it for and how reliable you need the supply to be.
4. Available space to install the tank.
5. How much you are prepared to spend.

For example: a house in the Melbourne rainfall area with a rainwater tank of 2,000 litres fed from 50 square metres of roof and connected to the toilets would save about 28,000 litres of mains water per year. This would fully use the tank's collection and storage ability.

A larger tank of 4,500 litres, fed from 100 square metres of roof would have the capacity to supply the washing machine as well, but not the garden. The mains water saving would nearly double to 56,000 litres a year.

To harvest the maximum amount of water, the tank needs to be sized so there is space in the tank whenever it rains. Constant use within the house (for example, toilet flushing and clothes washing) reduces the level in the tank so there is storage capacity for new rainfall events.

If the tank's primary purpose is to supply water for the garden, then it will need to be larger as garden watering tends to be more seasonal and intermittent and the water may need to be stored for longer. This helps to provide enough water for the garden through the hot summer months.

It is worth noting that if the tank is being installed to meet the 5-star building standards then, as a minimum, it must have a storage capacity of at least 2,000 litres and drain a roof area of at least 50 square metres and be connected to internal toilets.

Calculating the exact tank size you will need to meet your needs can be complicated, because how often and how heavily it rains varies from place to place in Victoria. For more assistance, we recommend you seek expert advice from your local water authority, licensed plumber or rainwater tank retailer. Remember to check with your local council to clarify the rules and regulations for installing and using rainwater tanks.

How do I know how much water I can harvest?

The amount of water you can harvest can be calculated from the size of the catchment area (m^2), the annual rainfall (mm) and the catchment efficiency (%). The catchment efficiency takes into account yield reduction due to surface saturation and evaporation, and for most of Victoria is around 85%.

Annual yield (L) =annual rainfall (mm) x catchment area (m^2) x catchment efficiency (%).

For example, if the average annual rainfall is 600 mm and the roof area is 250 m^2, then the potential annual yield will be:

600 x 250 x 0.85= 127,500 L.

It's important when you calculate the potential yield of rainwater from your roof that you are aware of the factors mentioned above, including usage patterns and the amount of roof area connected to the tank.

Installation

A licensed plumber must install the rainwater tank if it is to be connected to the internal plumbing of the house. This is to ensure there is no opportunity for cross contamination of the drinking water supply. It is also mandatory to install:

> a system to bring backup mains water to the toilets if the tank runs dry
> a backflow prevention device to prevent rainwater entering the reticulated water supply.

We also recommend that you install a first flush diversion device so that leaves and roof pollution are not washed into the tank.

The cost of tanks, pumps and accessories varies depending on the materials, volume and shape of the tank, and how it is installed and connected. Tanks are available in polyethylene, concrete or galvanised steel and there are models for every purpose and application – on stands, on the ground or below the ground.

In bushfire zones, it's preferable to use galvanised/colorbond steel or concrete tanks to better resist bushfire attack.

The typical cost of a 2,000 litre tank installation connected to all toilets ranges from $2,000 to $4,000. It's cheapest to install tanks when the house is first built. This does not include the cost of roof guttering and plumbing or any design and construction costs for arranging the roof layout to maximise water flow to the tank.

Maximising tank performance

Hints for areas with mains water connections

To get the most out of your rainwater tank, maximise the connected roof area and connect the tank to at least one consistent indoor use, such as toilet flushing or clothes washing.

The more uses you find for tank water, the greater quantity you'll use, saving more mains water and reducing the chances of tank overflow.

Toilet flushing and garden watering are the most obvious uses for rainwater because the water does not have to be treated to potable standard. Toilet flushing is considered the better option because it is a consistent year-round demand that increases the reliability of water supply and total water collected for a given size of tank.

Using the tank water only for garden watering will often lead to overflowing in the winter months and the tank running empty during summer.

You also have to consider the space that a tank will require and how to fit it on your property. If you have a long, narrow space, such as the space between your house and a fence, you may consider a series of smaller tanks.

Hints for areas without mains water connections

The size of a rainwater tank and the roof catchment area are even more important in homes not connected to mains water. Fortunately, many of these locations offer more outdoor space for much bigger rainwater tanks.

Households relying entirely on collected rainwater to meet their water demands will need to consider a tank with a capacity of 50,000 to 100,000 litres.

Previous experience is always a useful guide and we recommend asking your neighbours' advice.

Bushfire protection is an important consideration in many areas. The Country Fire Authority recommends rainwater tanks hold at least 22,000 litres of water with a pump that does not rely on the power supply.

Use for toilet flushing

In most of Victoria's southern regions where the average yearly rainfall is around 600 millimetres or more, a 2,000 litre tank collecting from a 50 square metre roof catchment area (the current 5-star building specifications) will provide reliable year-round water for toilet flushing.

In regions with significantly lower annual rainfall, mainly in Victoria's north-west, you will need a larger tank or greater catchment area.

For example, around Mildura where annual average rainfall is below 300mm, a 5,000 litre tank collecting from a 225 square metre roof area is the minimum necessary for year-round toilet flushing.

The bigger difference between summer and winter rainfall north of the Great Dividing Range compared with the rest of Victoria means that rainfall harvest from tanks is generally 10 to 20 per cent lower than areas of comparable rainfall south of the Divide (Plumbing Industry Commission).

On the garden

The size of your garden and types of plants it contains affect the amount of water you will need to keep it growing.

Most people use tank water for garden watering during summer when rainfall is lowest. This puts a strain on the tank reserve and means a larger tank is needed to store more water from wetter periods.

A garden hose connected to a rainwater tank has a typical flow rate of 300 to 600 litres per hour, so we recommend you buy the biggest tank you can afford that fits on your property.

For areas like Melbourne, Ballarat and Geelong with at least 600 millimetres average annual rainfall, we suggest you install a tank of between 4,000 and 5,000 litres for a reliable supply to water your garden.

Determining household water use

Average annual household water consumption in Victoria is 209,000 litres. But this varies between regions, with households around Mildura using about 550,000 litres and those in South Gippsland around 150,000 litres.

Within regions there are also big variations because of people's personal behaviour, what they do to save water, and the size and type of their gardens.

Bushfire safety considerations

Non-combustible (metal, concrete) rainwater tanks are important in all bushfire zones.

These should be of an adequate size with a pump and fittings that conform to Country Fire Authority requirements.

Further information

> www.ourwater.vic.gov.au Information on household water use, Victoria's Permanent Water Saving Rules, Waterwise Gardening and other developments.

> www.savewater.com.au Suppliers of rainwater tanks, greywater systems, water efficient irrigation products, hot water re-circulators and other water saving equipment

> www.epa.vic.gov.au/water/ Guidance on alternative water supplies and water recycling.

> www.pic.vic.gov.au about plumbing requirements for household water recycling and rainwater collection systems.

> http://enhealth.nphp.gov.au/council/pubs/documents/rainwater_tanks.pdf Guidance on the use of rainwater tanks, which includes comprehensive information about household rainwater tanks, including correct tank sizing.

> www.greenplumbers.com.au GreenPlumbers® businesses that can provide services including environmentally sustainable plumbing, construction work, gas work, heating and cooling work or products using certified GreenPlumbers®.

> www.bom.gov.au/climate/averages/ Information on climate averages for all regions of Australia from the Bureau of Meteorology, including rainfall data useful in helping to estimate the size of the rainwater tank that will best suit your requirements.

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

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Sustainability victoria

Victoria The Place To Be

> water efficient gardens

Included in this fact sheet:

- > **Minimising water, maximising amenity**
- > **Appropriate plant choice**
- > **Recycling in the garden**
- > **Mulching and composting**
- > **Alternative water sources**
- > **Smart watering methods**

This fact sheet explains useful steps you can take to make your garden more water efficient, and provides a comprehensive list of sources of further information.

What is a water efficient garden?

Our gardens are an extremely important part of our homes. Among other things, they provide visual aesthetics, a connection to our environment and an extension of our living space. They are a valuable space for exercise and relaxation, and contribute towards cooling our houses.

It is possible to have and maintain a garden even in times of drought and water restrictions. It just requires a bit of planning and the implementation of a few simple measures such as mulching to help keep your garden healthy all year round.

A water efficient garden uses the minimum amount of water to maximise the amenity. Water efficient gardens vary widely depending on size, shape, location and personal preferences, but all contain mechanisms to reduce the reliance on constant watering.

How do I make my garden water efficient?

Gardens can be very personal in design and function. However, no matter what the design, there are a number of basic mechanisms that can be used in all gardens to reduce water use. They include:

- > using mulch and compost
- > plant selection
- > using alternative water sources
- > effective watering.

You should always consider how these selections may impact on bushfire safety.

Mulch and compost

Mulch plays a critical role in helping reduce water loss from the soil. It acts like an insulating blanket, reducing evaporation by up to 70%. It also prevents weed growth and keeps the soil temperature more constant. Your choice of mulch will depend on your plant selection, desired look, availability and budget.

But dry mulch too near to your home at the time of bushfire attack may carry fire right to your door.

Mulches can be either organic or inorganic and come in a range of particle sizes, usually graded course, medium or fine.

Organic mulch

These mulches have the additional advantage of adding organic matter to the soil, which improves its ability to hold water and adds to the health of your plants. Healthy plants are more likely to survive times of reduced water availability. Organic mulches include straw-based mulches such as pea straw, lucerne, bean and sugar cane. Because they break down, they will need to be reapplied seasonally.

Inorganic mulch

These mulches include river pebbles, gravel and scoria and even recycled concrete. They don't break down and can come in a range of colours to complement the design of your house. And they can contribute significantly to your bushfire safety.

Tips for good mulching include:

> do not lay fine mulch more than 3 cm deep as it can form a hard layer and prevent water penetration. Medium sized mulches should be in layers of around 5 cm deep and coarse mulches around 8 cm deep

> organic mulching material will break down and needs to be topped up regularly, but adds nutrients to the soils

> mulching before summer will help keep the garden moist. In colder areas, mulching in winter will help to keep heat in the soil

> place watering systems under the mulch to reduce evaporation and ensure the water is getting to the roots of the plants

> do not lay organic mulch close to your home in a bushfire zone.

The main form of compost available to most gardeners will come from generating their own from green waste from around the home. There is also a wide variety of other products on the market, ranging from various manures, stable straw and mushroom compost.

Using green waste in the garden has a number of advantages:

> like organic mulch, it adds organic matter to the soil and improves moisture retention
> it improves the health of your plants, making them more resilient to dry periods
> it recycles green waste generated in and around the home, reducing landfill.

For more advice on mulch, consult your local nursery or visit the links at the end of this fact sheet.

Plant selection

Gardens can be very personal and we often have very strong views on what we want our gardens to look like. It is essential, however, that when designing our gardens, we take into account how much water is available through all the seasons.

Plants selection is critical to maintaining a water efficient garden. Choose plants that are native to your area or plants acclimatised to local conditions. These are not only more water efficient but are also more likely to attract native birds and insects. Your local nursery will be able to help you in your choice.

If you wish to grow more exotic plants or those from other climatic zones, then consider the following:

> group plants that need similar watering patterns together
> create microclimates within the garden, utilising features such as shade trees, building, fences and the garden orientation.
> consider ground moisture and leaf moisture in your selection – as both factors can assist with bushfire safety.

Alternative Water Sources

Gardening does not need high quality water, such as drinking water from the mains supply. Alternative water sources not only reduce the use of drinking water, but also provide the opportunity to maintain your garden even in times of drought and water restrictions.

The most common alternative water sources available for gardening include:

> rainwater collected off roofs and stored in tanks
> Class A recycled water via a third or dual pipe system
> treated or untreated greywater
> stormwater and dam water
> bore water.

Whatever alternative water source you are going to use, be sure to seek advice from your local water corporation and/or nursery to ensure it can be used for your desired purpose. Figure 1 overleaf offers a good guide to the uses of some alternative water sources. Bore water has not been included as the quality will vary widely depending on location. It is important to note that some plants will be more sensitive to bore and recycled waters.

Figure 1 - Use and benefits of alternative water supply options, Class 1 dwellings

	End use	Rainwater	Recycled (Class A)	Greywater: untreated	Greywater: treated (c)	Stormwater
Least sensitive	Toilet flushing	Yes	Yes	No	Yes	Yes
	Sub-surface landscape irrigation	Yes	Yes	Yes	Yes	Yes
	Surface landscape irrigation	Yes	Yes	Possible(b)	Yes	Yes
	Food crop/vegetable irrigation	Yes	Yes	No	Yes	Yes
	Outdoor uses such as car washing	Yes	Yes	No	Yes	Yes
	Cold supply to clothes washer	Yes	Yes	No	Yes	Possible(b)
	Swimming pool and spa pools	Yes	No	No	No	Possible(b)
	Evaporative coolers, fountains	Yes	Possible(b)	No	No	Possible(b)
	Cold water supply to dishwasher	Yes	No	No	No	Possible(b)
	Personal washing (hot & cold)	Yes	No	No	No	Possible(b)
Most sensitive	Drinking, cooking (hot & cold)	Yes(a)	No	No	No	No
Provides stormwater retention benefits		Yes	No	No	No	Yes
Need for management by the user and regular drawoff to maintain storage capacity		High	No	High	Med	High

Consistent with (DSE 2006)

(a) Where a reticulated drinking water supply is available, it is recommended that the supply be used for this purpose

(b) These uses would be subject to controls to manage potential risks

(c) Greywater would need to be treated to minimum standards for certain uses

When choosing an alternative water source for the garden – in particular, greywater or rainwater – some points to remember are:

> because garden watering is seasonal, the tank size needs to be large enough to store the water across winter for use in summer. Therefore, install the largest tank possible depending on your budget, land available, and the roof area you can collect from. For more information, see Sustainability Victoria's Rainwater Tank fact sheet
> untreated greywater cannot be stored for more than 24 hours and should not be used for growing vegetables. For more information, see Sustainability Victoria's Recycled Water and Greywater fact sheet.
> your choice of garden plants is extremely important. Consult your local nursery for advice.

Effective Watering

No matter what source of water you use, it needs to be used effectively to minimise wastage. The best way to do this is to install a well designed irrigation system.

Some things to remember:

> The water should be delivered to the roots rather than the leaves. Use drip irrigation rather than spray irrigation and place the irrigation heads under the mulch.
> Use good quality fittings to reduce leakage and breakages.
> An automatic timer prevents systems being left on by accident and can be turned on automatically at night to minimise evaporation and meet some water restriction requirements.
> Never water in the middle of the day
> Many plants are hardier than we expect – only water when necessary.
> If hand watering, use a trigger nozzle.
> Maintain your garden to keep it healthy. Remove weeds as these compete for water.
> For more sensitive plants and pot plants, cut the base off a plastic bottle and bury it upside down next to the plants – any water you pour in will then go straight to where it matters: the roots.

When you are planning your watering system, it is important to be aware of current water restrictions in Victoria. Visit www.ourwater.vic.gov.au to find out more.

Can I still have a lawn?

Lawns play a very important part in many gardens. They are often attractive, provide an external living and playing area, and can contribute to cooling the house. However, they do use a significant amount of water and can be very difficult to maintain during hotter months.

Consider reducing the size of your lawn or using an alternative to lawn, such as native grass, water permeable paving or even synthetic grass.

If you still wish to have a lawn, make sure you use a drought tolerant variety. Remove weeds and, when mowing, raise the blades to provide some protection against evaporation.

Remember, the watering of lawns with mains drinking water is prohibited under some water restrictions.

Bushfire safety considerations

Select plants with higher leaf moisture content for better bushfire resistance.

In rural situations, consider planting suitable species as bushfire screens to protect buildings from wind and radiant heat.

Keep your garden hoses protected at times of bushfire attack for when you most need them to protect your home.

Further information

> www.ourwater.vic.gov.au
Information on household water use, Victoria's Permanent Water Saving Rules, Waterwise Gardening and other developments.

> www.savewater.com.au
Information on suppliers of rainwater tanks, greywater systems, water efficient irrigation products, hot water re-circulators and other water saving equipment.

> www.irrigation.org.au
Guide to Good Garden Watering.

> www.wsaa.asn.au/smartwatermark/approved.htm
About the Smart Approved WaterMark, a labelling program for outdoor water saving products and services.

> www.greenplumbers.com.au
Information on licensed GreenPlumbers® businesses that can provide services including environmentally sustainable plumbing, construction work, gas work, heating and cooling work or products using certified GreenPlumbers®.

> www.bom.gov.au/climate/averages/
Information on climate averages for all regions of Australia from the Bureau of Meteorology, including rainfall data useful in helping to estimate the size of the rainwater tank that will best suit your requirements.

> Ramsay, C. and Rudolph, L. (2003) *Landscape and Building Design for Bushfire Areas*, CSIRO Publishing, Melbourne.

> Peate, N., MacDonald, G. and Talbot, A. (2006) *Grow whatever: over 3,000 Australian native plants for every situation, special use and problem area*, Bloomings Books, Melbourne. (Includes CD-ROM).

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

ENV015 5.05 July 2009

Sustainability victoria

Victoria The Place To Be

Who should I talk to next?

Victoria
We will rebuild

Sustainability victoria
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> finding sustainable tradespeople, professionals and products

Included in this fact sheet:

- > Finding sustainable builders and tradespeople
- > Finding sustainable landscapers and gardeners
- > Find an energy efficiency assessor
- > Sustainable product and service directories

In this fact sheet, you will find contacts for accredited environmental services ranging from builders to trades (electrical, plumbing and painting), gardeners and landscapers, and energy efficiency assessors. Some useful sustainable product directories are also provided.

The right advice

When you are building or renovating your house, it is much easier to achieve better environmental outcomes if you work with people who have the skills and experience to advise you on effective sustainable options for your house. In Victoria, we are lucky to have a wide range of formal training and accreditation schemes that provide a greater level of service and confidence to people who are looking for environmental features and performance.

The following list provides a summary of professional associations, certifications and product directories that will help you to design and build a more sustainable home.

resourcesmart.vic.gov.au/bushfirerebuildsupport

GreenSmart Builders

GreenSmart builders are accredited through the Housing Industry Association (HIA) and provide advice on creating sustainable homes, developments and building products for consumers and the housing industry.

http://tradebuild.com.au/search/default.aspx
or phone (03) 9280 8200

Green Living Builders

Green Living Builders are accredited through the Master Builders Association and can provide you with advice about the benefits of making your home more comfortable and efficient.

www.mbav.com.au/vpLink.aspx?ID=8533
or phone (03) 9411 4500

GreenPlumbers

GreenPlumbers, is an initiative by the Master Plumbers and Mechanical Services Association of Australia (MPMSAA). GreenPlumbers can advise you on a range of topics including the benefits of energy efficiency and solar hot water, water conservation and the most appropriate and cost effective appliances to suit your individual needs.

www.greenplumbers.com.au/products/services/find-a-greenplumber
or phone 1300 368 519

EcoSmart Electricians

EcoSmart Electricians are certified through the National Electrical and Communications Association (NECA) to provide consumers with advice about saving energy in the home using energy efficient lighting, pumps, fans and motors, solar generation systems, heating and cooling.

www.ecosmartelectricians.com.au/locate.html
or phone (03) 9645 5533

Green Painters

Green Painters are licensed, fully insured and certified tradespeople who adhere to an Environmental Code of Practice. They offer advice and services in such areas as eco-preferable and natural paints, choosing colours and textures, saving money and cutting carbon emissions.

www.greenpainters.com.au/services.htm
or phone 0402 312 234

Home Sustainability Assessors

Home sustainability assessors are trained advisors who, through home visits, provide tailored advice on how to make homes and lifestyles more sustainable and reduce environmental impact.

resourcesmart.vic.gov.au/for_households_3636.html
or phone 1300 363 744

FirstRate Accredited Energy Raters

Accredited assessors are qualified to issue certified ratings of house plans for submission to Councils. Sustainability Victoria accredits these assessors to provide energy ratings for houses in Victoria.

www.sv.sustainability.vic.gov.au/buildings/firstrate/firstRateListSort_new.asp?search_criteria=
or phone 1300 363 744

Photovoltaic (solar power) system designers and installers

Photovoltaic system designers and installers accredited by the Australian Business Council of Sustainable Energy.

www.bcse.org.au/default.asp?id=119
or phone (03) 9929 4100

Landscapers

Sustainable Gardening Australia has a certification program for landscape professionals to design, construct and maintain landscapes that:

> minimise water use
> minimise chemical use
> enhance biodiversity
> complement natural systems
> minimise invasive plants.

www.sgaonline.org.au/eclips.html
or phone (03) 9850 8165

Green Building Council of Australia

A national, not-for-profit organisation that is committed to developing a sustainable property industry for Australia by encouraging the adoption of green building practices. A directory of Green Star accredited professionals is available on their website.

www.gbca.org.au
or phone (03) 8612 2000

Green Pages Australia

An online directory of organisations that offer services and products with clear environmental benefits.

www.thegreenpages.com.au

The Green Directory

An online resource for locating green businesses, products and services. All businesses in the categories have been selected for their 'green' attributes and sustainable business practices.

www.thegreendirectory.com.au/index.php

Sustainable Architects

An increasing number of architects have training and experience in all aspects of sustainable design, construction and lifestyles.

www.architecture.com.au/vic
or phone (03) 8620 3866

Architects Bushfire Home Service

A number of architecturally designed homes for bushfire areas are available for free from

www.wewillrebuild.vic.gov.au/clean-up-a-rebuilding/architects-bushfire-homes-service.html
or phone (03) 8620 3866

Archicentre Concept Home Design Service

A free service for those planning to rebuild after the bushfires.

www.archicentre.com.au/rebuild/index.htm
or phone 1300 134 513

For further information or a copy of this fact sheet, go to resourcesmart.vic.gov.au/sustainablerebuildingideas or please call Sustainability Victoria on 1300 363 744.

Who should I talk to next? > finding sustainable tradespeople, professionals and products

Notes